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Investigate Reclamation Practices

During the last few years the railroads have carried on reclamation work more extensively than ever before. In some cases the difficulty of securing material made reclamation necessary, and this was the deciding factor, rather than the saving effected. Now that conditions are becoming more nearly normal some of the reclamation practices put into effect during the war should be investigated to see whether they are economical under present conditions. It is quite possible that in many cases the purchase of new material would be cheaper in the end. There is another phase of the problem brought up by the changes in the prices of material and in the rates of wages which is perhaps of even greater importance, namely, the advisability of adopting more extensive reclamation policies. The advance in the prices of some materials has been greater than the advance in labor costs. New tools and new methods have been introduced, and some work that was uneconomical under former conditions can now be carried on at a saving. The entire status of reclamation work has been changed and present practices must be carefully reconsidered if costly mistakes are to be avoided.

Grinding Twist Drills

The practice of grinding all twist drills on special grinding machines is quite general in railroad shops, and it might seem that any comments on the advantages of this method are superfluous. Observation in some small shops, however, indicates that grinding by hand on ordinary stand grinders is by no means obsolete. Even in shops equipped with drill grinders mechanics often grind drills by hand to avoid making a trip to the tool room to obtain a sharp drill. The desire to save time in this way is praiseworthy, but the object is seldom attained. Unless the drill is ground on a special machine one edge is invariably longer than the other, and as a result the drill uses more power than it would if properly ground, its capacity to stand up under high speeds and heavy feeds is reduced and it becomes dull more rapidly than if both edges did an equal amount of work. The influence of grinding on the endurance of drills was illustrated by comparative tests of drills used for forming telltale holes in staybolts. Drills of small sizes are considered easy to sharpen by hand, yet machine sharpened drills permitted much more rapid work and finished 80 per cent more holes before becoming dull.

Locomotive Front End Design

There is probably no other part of the modern locomotive which is designed on such an unscientific basis as the draft appliances. It is surprising but nevertheless true that no attempt has been made to establish general rules for proportioning nozzles and stacks since 1902, when a series of tests was conducted by the *American Engineer* with the co-operation of the Master Mechanics' Association. During recent years several roads have made tests to determine suitable front end proportions for certain classes of locomotives. These have added little to the general knowledge of front end design, but have emphasized the need for further information on the subject, as in practically every instance these tests were undertaken only after it had been found that front ends designed according to the usual practice would not give satisfactory results.

The large amount of power used to develop draft in a locomotive boiler is seldom realized. In a simple locomotive at ordinary running speeds the back pressure is often equal to one-fourth of the mean effective pressure, in which case the draft requires one-fourth as much power as is developed by the cylinders. In compound locomotives the loss is still greater. Even a slight reduction in back pressure will cause a considerable increase in the power developed by the locomotive. One recent test showed that by a change in the front end arrangement, the back pressure could be reduced

six pounds and the power delivered by the locomotive increased 188 hp.

A general redesign of the draft appliances on many locomotives is very desirable. This work cannot be done until the best proportions for the front ends of large locomotives are definitely established. However, the comparatively low efficiency of circular nozzles as compared with nozzles of irregular form has been proved and economies that are well worth while can be obtained by applying the later form of tip to existing locomotives as a temporary expedient until the best arrangement of draft appliances for modern motive power is developed.

Condemning Limits for Steel Wheels

The relocation of the limit of wear groove for wrought steel wheels ½ in. from the inside of the rim instead of ¾ in. as at present was discussed in the report of the Committee on Car Wheels presented at the convention of the Mechanical Section of the American Railroad Association. The committee stated that other factors besides the strength of the wheel are involved and suggested that a circular of inquiry will be sent out covering these points. Elsewhere in this issue will be found an account of tests recently conducted to determine the strength of the flange on steel wheels with the treads turned to the proposed condemning limit. These tests indicate that wheels worn to within ¾ in. of the rim still have an ample factor of safety to resist lateral stresses.

The possibility of getting more mileage from rolled steel wheels is so important that it should be carefully considered. The committee mentions the maintenance of drawbar height, truck clearance and the effectiveness of brakes as factors that might prevent the change in the scrapping limit. Some slight alterations in the trucks would probably overcome these difficulties in most cases, and if it were feasible the change should prove economical as it would reduce the cost of wheel renewals throughout the life of the car. Even though all trucks cannot be changed to admit of wearing the wheels to smaller diameter, there seems no reason why roads that are able to use wheels until the rims are ¾ in. thick should not be allowed to do so.

Spontaneous Combustion in Coal Chutes

The destruction of several coaling stations by fires, due presumably to spontaneous combustion in the coal, recently led the Insurance and Fire Protection Section of the Railroad Administration to issue a warning regarding conditions in and about coal chutes. When such accidents occur they cause serious interruption to traffic and every precaution should be taken to guard against them. Spontaneous fires in coal have been carefully studied and while all the causes are not definitely known, certain conditions that increase the fire hazard have now been well established.

Coal which is freshly mined may absorb oxygen from the air and the more finely divided it is the greater the tendency to heat due to this action. Damp coal also heats more readily than dry coal. Wood, greasy waste, or other combustible matter, furnishes a starting point for fire and should be carefully removed before loading the coal into the chutes. Probably the majority of fires in coal chutes could be prevented by avoiding the accumulation of fine coal in the pockets for any considerable period. The screenings will settle to the bottom, particularly in large pockets, and if the chute is not completely emptied this lower strata may remain undisturbed long enough to absorb oxygen and finally become ignited. Coal chutes should be emptied regularly once a day to clean out the fine coal and if there are any pockets from which the coal will not flow by gravity, they should be shoveled out or remodeled to remove the chance for spontaneous combustion which otherwise will exist.

The Welder in Locomotive Repairs

The importance of having competent welders, particularly in the repair of locomotive boilers, was again emphasized at the recent convention of the Master Boiler Makers' Association. The boiler being, so to speak, the heart of the locomotive, any laxity in its construction or inspection is usually followed by disastrous results. One vital feature of boiler making and repairing is the practice now becoming quite extensive, of welding patches to the sheets when repairing cracked or otherwise defective parts of the boiler. There is no other form of repair work that may be so easily slighted through incompetent or careless workmanship and still pass the required inspection, only to fail at some critical moment in the operation of the locomotive. Many excellent papers are published from time to time in the technical journals, devoted to railroad questions and it is the duty of the men who have taken up welding to keep themselves fully informed concerning the methods and progress of the art of welding. Both the electric and the acetylene gas welding apparatus have been developed to a point where they require only careful and intelligent operation to secure satisfactory results. Anyone taking up this line of work may be assured of every assistance from the manufacturers of the welding outfits, as well as from their shop foremen and should not fail to take advantage of every channel of information available. The importance of careful welding in every repair made to a locomotive boiler cannot be too strongly impressed on those who are engaged in this work.

Labor and Scientific Research

One of the significant actions taken by the convention of the American Federation of Labor, recently held at Atlantic City, was the passing of a resolution defining the attitude of the organization toward scientific research in its relation to industrial progress. The resolution sets forth that a broad program of scientific and technical research is of major importance to the national welfare, should be fostered in every way by the Federal government and that the activities of the government itself in such research should be adequately and generously supported in order that the work may be strengthened and extended. In setting forth the reasons for this action the resolution states that the productivity of industry is greatly increased by the technical application of the results of research in the various sciences, as well as in engineering and agriculture, and that the increased productivity in industry resulting from such research is the most potent factor in the ever-increasing struggle of the workers to raise their standards of living. One of the most significant reasons given for the action taken is that the importance of such productivity must steadily increase, since there is a limit beyond which the average standards of living of the whole population cannot progress by the usual methods of readjustment, which limit can only be raised by research and the utilization of the results of research in industry. The recognition of this situation by the great national labor organization is a sign of a most hopeful condition in the possibility for a better understanding between the various agencies which make up the national industrial structure. It is a platform on which the investor and the manager, as well as the worker, have every reason to take a common stand. Much excellent work has been done by the various bureaus of the federal government which has been of great practical value, and with proper support in the way of adequate appropriations the practical value of this work could be greatly increased.

Co-operation with Other Departments

In an organization as complex as a large railroad system the proper inter-relation of the departments presents a difficult problem. With each man engrossed in his own work and carrying out the plan of his immediate superior, conflicts of authority with consequent friction and bad feeling are almost sure to occur. If, as is often the case, all business matters are handled by mail or by wire and personal contact is eliminated minor irritations sometimes produce an effect out of all proportion to their actual importance and animosity is created between the different parts of the organization that has a very harmful effect on the morale. How often the roundhouse force vilifies the back shop force, which it has never seen, or the yard employees, with whom daily battles are fought over the telephone.

No base ball team could be successful if the first baseman refused to catch the balls which the short stop threw to him and no railroad can have a high record for efficiency unless there is teamwork among the different departments. If the roundhouse foreman and the yardmaster met occasionally when there were no differences to be decided between them, the acquaintance would no doubt lead to better relations during working hours, with the result that Bill would take more interest in telling Jim what trains he expected to run and Jim would try to have the power ready in time to meet Bill's schedule. System is a wonderful thing, but some of our railroads are overburdened with it. A few hours a week devoted to common human intercourse between members of different departments is the best lubricant for any organization and one that is often sorely needed.

Retrenchment and Maintenance

The Railroad Administration has recently inaugurated a policy of retrenchment in an effort to reduce the large deficit that is being incurred. Much criticism has been directed at the railroad companies in the past because of the methods adopted when reductions in expenses seemed necessary, due to financial and traffic conditions. Beyond a doubt much of this criticism has been merited. The serious objection to any drastic retrenchment policy is that it attempts to control expenses without regard for the natural factors that influence costs and, therefore, often leads to the adoption of measures which in the end prove false economies.

Reductions in unit costs are often demanded when there is a decrease in traffic, but this is contrary to the natural tendency of unit costs to increase as the business decreases. Heavy loading of cars and locomotives is essential for economy of operation, but where there is a reduced traffic to move, it is almost impossible to haul the maximum average tonnage per train. Thus the cost of fuel and of wages for train and enginemen have a tendency to increase in proportion to the amount of traffic handled. The possibilities for economy in this direction are small and any saving must be effected almost entirely in the cost of maintenance of way and repairs to locomotives and cars. While the *total* expense for equipment maintenance will fall as the traffic declines, the *unit* expense has a tendency to increase, and an immediate substantial reduction in the unit costs can be secured in only one way, by slighting the work.

During the war equipment was not maintained to a high standard. There has been a marked improvement in the last few months, but it would be a serious mistake if the roads, in an attempt to make a show of economy, should again neglect the little things that are so important in railroad operation. The ultimate economy of a high standard of maintenance cannot be questioned and if the officers of the mechanical department could impress on their superiors the many ways in which the elimination of small items leads to much larger expenses, some of the drastic reductions in maintenance allowances might be avoided. The neglect of minor repairs causes equipment to deteriorate rapidly. Lack of attention to draft appliances, flues, fireboxes and grates results in inefficient combustion. Valves out of square, packing blowing, or auxiliaries in poor condition cause a waste of steam. These factors contribute to delays on the road and increase the expense of wages for train crews. Poor maintenance inevitably leads to waste and inefficiency. The Railroad Administration has indicated that an effort will be made to bring about a marked reduction in the cost of equipment maintenance. So far as this campaign is confined to developing improved methods, it deserves, and will surely receive, hearty support. It is to be hoped, however, that the administration officers will not resort to the short sighted policies that have been used under similar circumstances in the past to effect a reduction in expenses.

NEW BOOKS

Cambria Steel Handbook. Prepared and compiled by George E. Thackray, C.E. 603 pages, illustrated, 4½ in. by 6¾ in., flexible binding. Published by the Cambria Steel Company, Philadelphia, Pa.

This is the twelfth edition of the Cambria handbook and in addition to a thorough revision of all data pertaining to the various structural steel sections manufactured by the Cambria Steel Company, it contains a large amount of new material covering the wider range of structural steel sections now manufactured, and includes additional tables of use in calculations involved in the design of structures in which the sections are used. Among the new sections for which illustrations and properties are included in the new edition are a number of bulb angles, small channels for cars, ship channels, T-bars and three sizes of rolled steel car stakes. Among the large number of new tables which have been added are weights of flat and corrugated steel sheathing, roof truss dimensions and stresses, sizes of spikes and wood screws, square roots and cube roots of fractions, weights of circular steel plates, trigonometric formulae, etc.

Applied Mechanics, Volume II, Strength of Materials. By Charles E. Fuller, S. B., and William A. Johnson, S. B., professors of theoretical and applied mechanics, Massachusetts Institute of Technology. 556 pages, 6 in. by 9¼ in., illustrated, bound in cloth. Published by John Wiley & Sons, Inc., New York.

While this book has been prepared primarily for the students of engineering in the Massachusetts Institute of Technology, it covers the fundamentals of applied mechanics to such an extent that it will be found a valuable text book for any engineer's library. A person using this book should have a fundamental knowledge of differential and integral calculus, the principles of statics and dynamics and the methods of determining centers of gravity and moments of inertia of areas and solids. The subject has been developed logically, special care being taken to point out the limitations of the different theories, and emphasis is laid on the divergence of the conditions met in practice from ideal conditions. Graphic methods of solution have been freely employed and a number of problems involving the application of each of the theories discussed have been included and solutions given where it has appeared that these would be an aid to a clear understanding of the subject. The authors of the book have had many years' experience in teaching the subject, and this book is the result of their most careful study of the manner in which such an important subject can be more clearly and firmly fixed in the mind of the student. It covers the physical properties of materials, a study of stress and strain with their application to beams of various loading, and a discussion of the general theory of flexure, columns, shafting and springs, curved bars, arches and catenaries, cylinders and plates, and reinforced concrete beams and columns.

COMMUNICATIONS

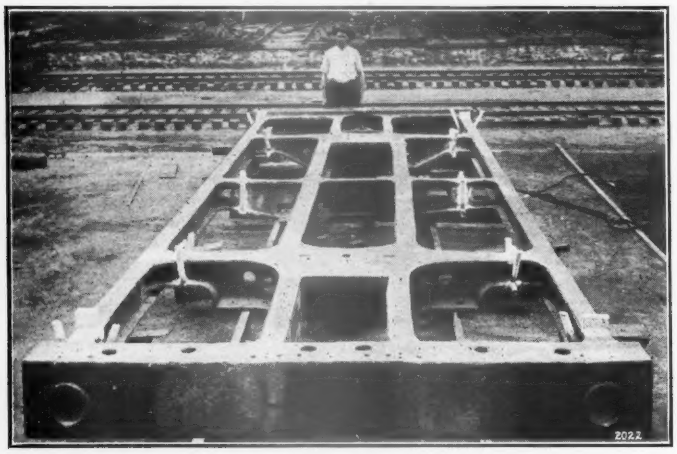
THERMIT VS. AUTOGENOUS WELDING

Clifton Forge, Va.

To the Editor:

I have read with a great deal of interest the article "Oxy-Acetylene Welding Problems," by Mr. W. L. Bean, in the February issue of the *Railway Mechanical Engineer,* and was particularly interested in the description given by him of reclaiming a damaged Commonwealth cast steel one-piece tender frame. We had an occasion to make repairs to a frame similar to this one, but used the Thermit process of uniting the members of the frame after they had been cut apart for straightening instead of using oxy-acetylene or electric processes, both of which we have in use at these shops.

The frame shown in the illustration was 28 ft. long and 9 ft. 6 in. wide, the members being of heavy I-beam sections; the weight was approximately 15,000 lb. The frame was very badly bent and in order to straighten it we found it necessary to cut the side sills. These sills were then straightened in a pneumatic press after being heated in a large furnace. The rest of the frame was then heated by the use of a blow torch and straightened, after which the side



Cast Steel Tender Frame Reassembled by Thermit Welding Process

sills were clamped into position and welded with Thermit, making ten welds in all.

In making the welds 1,150 lb. of thermit was consumed. I should like to call your attention to the following comparative results as shown by the two operations, which indicate an advantage in time, cost and strength of weld by the method we used over the New Haven method:

Time—The method used by the New Haven consumed about six weeks. The time consumed in preparing the frame and welding it at the shops at this point was only 10 days.

Cost—The cost of reclaiming the frame on the New Haven was about the same as a new frame. The cost of reclaiming the frame with the Thermit process was $502.50. A new frame would have cost approximately $1,500.

Strength of Weld—The Thermit weld leaves no doubt as to the strength of the weld, owing to the thorough amalgamation of the metal due to the intense heat of the Thermit reaction. After 15 years' continuous use of the Thermit process of welding at the Clifton Forge shops we have found it to give us the best results. Especially is this true where heavy sections are to be welded.

Since November, 1908, we have made approximately 300 frame welds, and it is very gratifying to say that only six failures have occurred. The welded tender frame has been in continuous service for upwards of two years.

E. A. Murray, Master Mechanic.

INADEQUATE MAIN BOXES

Allston, Mass.

To the Editor:

The communication on inadequate main boxes from Charles F. Prescott, which appeared in the April, 1919, issue, has awakened many thoughts in the minds of persons who are interested in this subject. The wear of main driving boxes on heavy locomotives is one of the chief factors causing engines to be shopped with a small amount of mileage; that is, the main box does not give service in proportion to the other parts of the engine, and distributes the effect of its poor condition to the other parts.

This necessitates the treatment of main driving boxes at short intervals, or an engine going to the shop on small mileage, because of the wear and tear due to the bad condition of the main driving boxes. To all who are familiar with this condition, the problem is how to avoid it without the introduction of something which will require more expert attention. One of the most important features of the locomotives designed in the United States is simplicity of construction and the abuse they will stand when maintenance is neglected.

The solid crown brass is a development away from the three-piece crown brass with a wedge center. The solid key in the eccentric is a development away from the rifled key and set screw which gave us the slipping eccentrics.

Mr. Prescott says that the lengthening of bearings toward the neutral axis of the axle has not resulted in improvement. My opinion is that the reason we have found no improvement in extending the bearing toward the neutral axis is that we have not made a scientific distribution of the work on the bearing surface; that we have not made any provision for compensation of the difference in the coefficient of expansion of the various metals massed together between the frames.

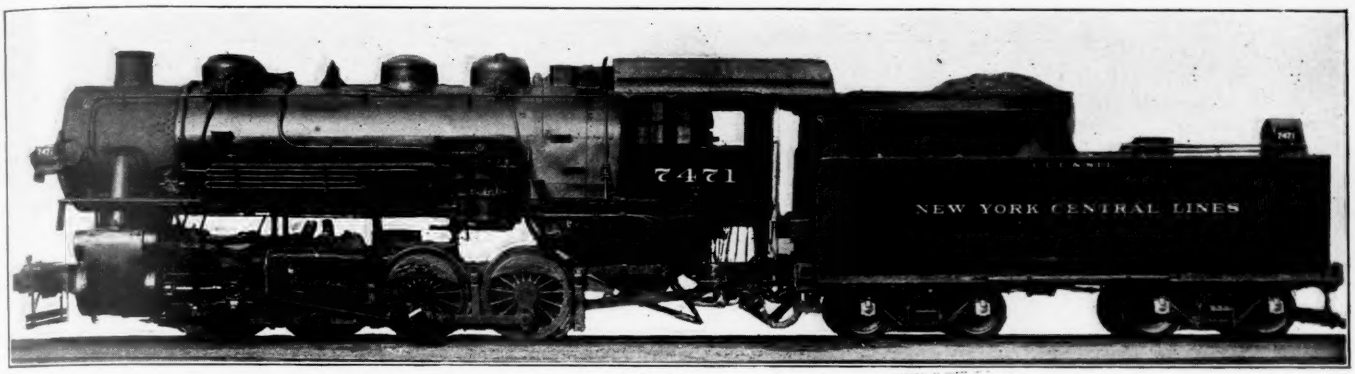
The bearing surface of the crown should be bored out between the ends of the brass, allowing a bearing surface on each end to prevent the escape of grease, so as to bring the bearing down on the sides where the piston thrust is concentrated. The bearing on the shoe and wedge should be cut away for about one-third of the width of the shoe and wedge face on each side so as to concentrate the lead from the thrust of the piston in the center of the points of bearing between both ends. For example, assume that the width of wedge and shoe faces were 15 in.; after having fitted them up for the box the next operation would be to set them up on the planer and, starting on lines 2½ in. each side of the center, plane the faces to allow 1/64 in. clearance at the edges. This will permit the box to align itself to the journal bearing.

As driving boxes are now fitted, the ends of the bearing wear and cause pounding because the shoe and wedge hold the box so that it cannot adjust itself to the axle alignment.

To compensate for the coefficient of expansion I would suggest a spring under the wedge which will balance the weight of the wedge and also compensate for inertia when the engine is riding, with provision made for the wedge to unload itself by backing down when loaded by virtue of the expansion. This is not to be construed to mean a wedge with a constant spring thrust to maintain adjustment for wear.

The ¾ in. per ft. taper used in the wedge may be proved mathematically as about equal to the coefficient of friction between the wedge and bearing on the frame so that zero may be taken as the amount of work necessary to hold the wedge up against the piston thrust.

Frequently the brasses are loose at points in the box and this is caused by the inequality of expansion of the different metals, the consequent compression being exerted on the metal offering the least resistance. John C. Murdock.



Eight wheel Switcher Converted from Consolidation Type Locomotive

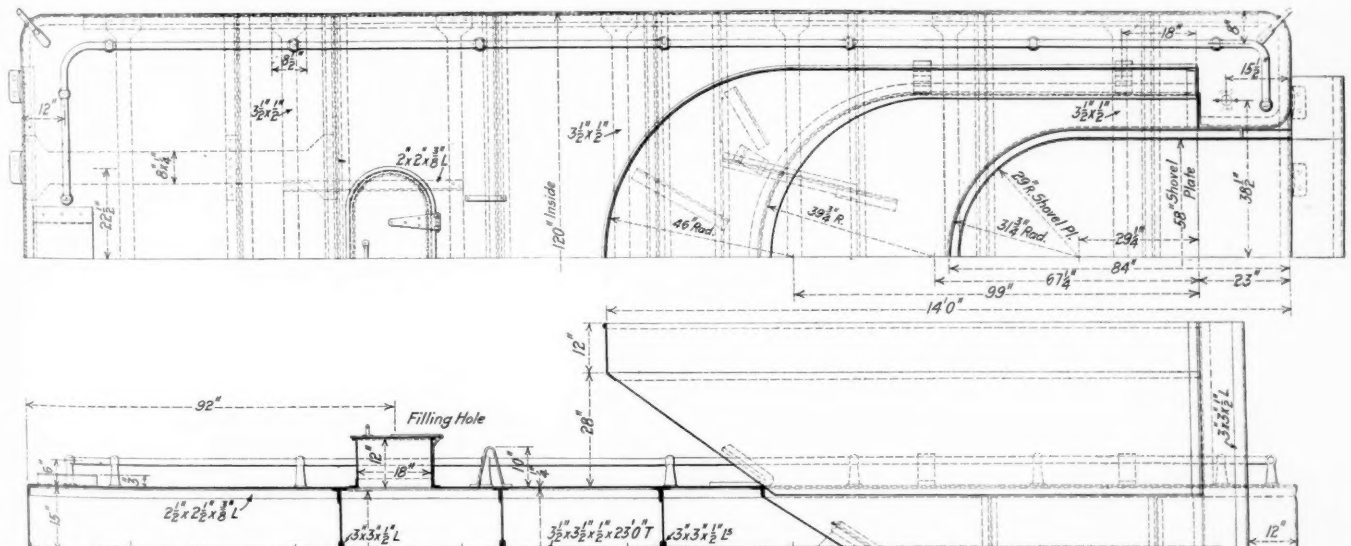
C. C. C. & St. L. 0-8-0 Switchers

Consolidation Type Converted with Special Features to Adapt Engines for Switching Service

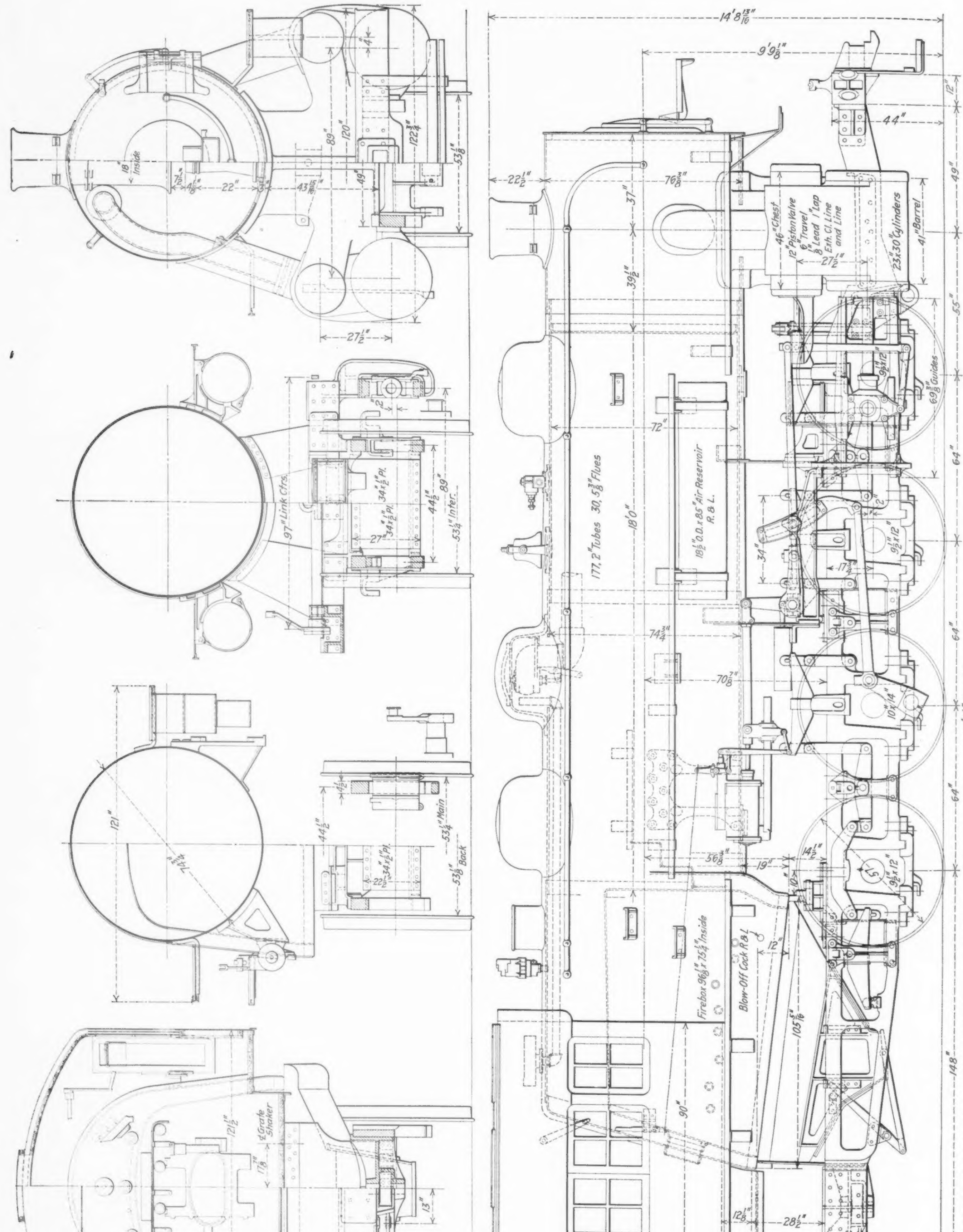
BY R. W. RETTERER
Assistant Mechanical Engineer, C. C. C. & St. L.

THE constantly growing demand for increased locomotive capacity due to the heavy freight traffic and the increase in train loads has necessitated heavier and more powerful switching locomotives to handle efficiently the heavy trains brought into the terminal yards. A switching locomotive in order to meet these demands must necessarily be equal, at least, in tractive effort to the heaviest road locomotive, and must also be of such design as to insure quick operation. To accomplish this the Beech Grove shops of the Cleveland, Cincinnati, Chicago & St. Louis have completed the first of 15 eight-wheel type switching locomotives in which a number of interesting features have been incorporated.

As the prices of material entering into the construction of locomotives were much above normal, it was found a considerable saving could be made by converting Consolidation type locomotives into 0-8-0 switchers. The Consolidation locomotives selected were built in 1900, having a tractive effort of 43,000 lb., 22-in. by 30-in. cylinders, and 57-in. driving wheels. Conditions had shown that these locomotives were not sufficiently powerful to handle a train of satisfactory tonnage at scheduled speeds in freight service. In designing the new locomotive it was imperative that, to keep down operating costs, every hour of high priced labor should be made to produce the utmost. With this result in view, the



Design of Tender Tank Which Delivers 75 Per Cent of the Coal at the Coal Gates



Side Elevation and Sections of Big Four Eight-wheel Switcher

design of each item that makes for economy of operation was carefully gone over, considering not only the railroad company's interest but also the convenience for the shop and enginemen.

The elimination of the front truck with the consequent increase in weight on driving wheels made it necessary to provide larger cylinders, 23-in. by 30-in. cylinders of the outside steam pipe design being applied. The relation of boiler capacity to the cylinder demand, calculated in accordance

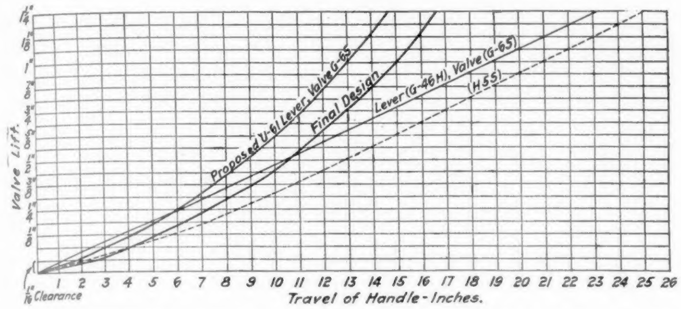


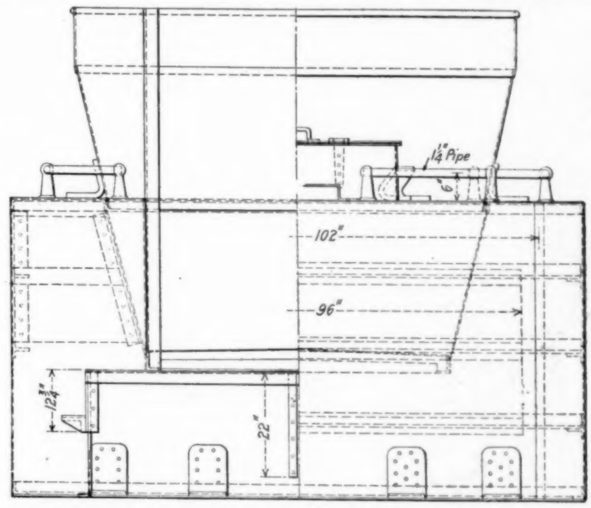
Fig. 1—Diagram Showing Relation Between Valve Lift and Travel of Handle for Various Types of Throttle Rigging

with Cole's ratios, shows ample boiler capacity both as to heating surface and grate area. The boiler is of the radial stay, straight top, wide firebox type having 177 2-in. tubes and 30 5⅜-in. flues. The Locomotive Superheater Company's type A superheater and the American brick arch are used. The total heating surface is 2,621 sq. ft. and the superheating surface 551 sq. ft., with a grate area of 50.2 sq. ft. The boiler is fitted with a one piece pressed steel dome.

The smokebox design is generally similar to that of a Mikado locomotive. The front end is mounted on the smokebox by a hinge of cast steel, amply strong to permit swinging the boiler front to one side, permitting easy access to the superheater units and other front end parts without the entire removal of the boiler front. The hinge is fitted with an eccentric cam which when turned, pushes the front end off the studs, allowing it to swing to one side. This feature eliminates the necessity of using several men when the smokebox front must be removed in the roundhouse.

Steam is supplied to the cylinders through a 7½-in. dry pipe and 7-in. branch pipes, the admission being controlled by a balanced throttle valve. The throttle rigging is of a different design than is ordinarily used. The curve shown in the throttle rigging drawing indicates the lift of the valve plotted against the movement of the throttle lever for these locomotives and for other classes having different throttle rigging. This action gives an easy opening throttle on the start, and also provides for a quick acting engine. The rigging is adjustable to permit taking up the wear, as will be noted from the general arrangement shown in Fig. 2. The Walschaert valve gear and the Ragonnet power reverse gear are used, the controlling levers being conveniently located in the cab.

Each frame is a single steel casting 37 ft. 0 in. long. The top rail is 4½ in. wide by 5¾ in. deep, the section changing to 4½ in. wide by 6¾ in. deep over the jaws, the lower rail being 4 in. deep. The single rail to which the cylinders are bolted is 4½ in. wide by 10 in. deep. The frames are securely tied between each pair of drivers with a cast steel cross brace. The brake rigging is designed so as to eliminate the large holes through the frame for the brake hanger pins. The brake hanger supports are bolted to the frame and a short pin is used for supporting the hanger. This feature has done away with the annoying hanger pin failures where the pin is fitted into the frame. A combination brake fulcrum and cross equalizer support is used which permits using a short shaft for the brake fulcrum in place of the usual shaft



Half End Elevations of the Big Four Switch Engine Tenders

which extends from frame to frame. This permits the removal of one fulcrum independently of the other, also where the clearances are small as is usually the case, the short shaft can be readily removed.

In designing the spring rigging the center of gravity of frames, cross ties, cylinders, etc.,—that is, all parts above the springs except the boiler and attachments,—was calculated as one factor, and of the boiler and attachments as another factor. The boiler was then located so as to make the center of gravity of the whole slightly to the rear of the center line of the wheel base. From these data, the load on each spring was calculated, and the equalizers between drivers were designed so as to be in balance with the load applied. The results of this method are shown in the scale weights of the first engine out of shop, the additional weight on the main wheel being largely due to the weight of heavier rods, counterbalances and valve gear parts connected to it. The weight on each pair of drivers is as follows:

Front wheels	Intermediate wheels	Main wheels	Rear wheels	Total
54,100 lb.	53,200 lb.	57,800 lb.	54,900 lb.	220,000 lb.

The question of making available at the coal gate of the

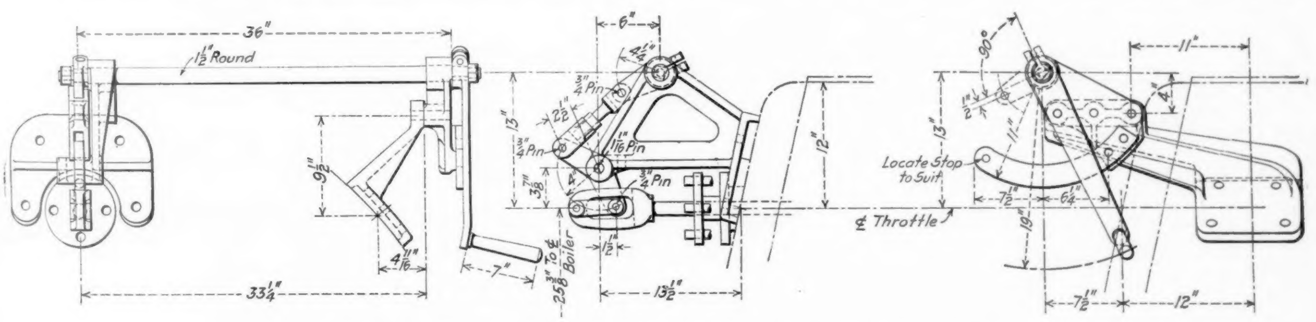
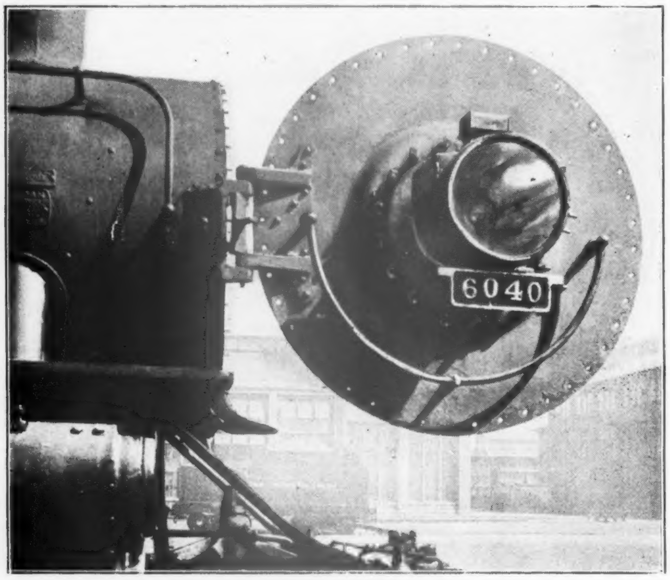


Fig. 2—Arrangement of Throttle Lever Used on Big Four Switchers

tender a greater per cent of the coal carried without shoveling down by the fireman or taking coal at frequent intervals has become more a matter of importance as the size of engines and trains has increased. To obviate the necessity for coal pushers an investigation was conducted which resulted in the final design of a tender tank with a conical space for coal, the capacity being 9,000 gal. of water and 12 tons of coal. Actual service results show that the coal works forward to the fireman without shoveling down. Some of the features of the design are as follows: Practically all coal is available to the fireman; 75 per cent without opening the gates. The tender carries the same amount of coal as other designs with additional water space of approximately 1,000 gal. The rusting of slope sheets due to the collection of old coal is eliminated. An engine can be coaled with but one spotting under the dock. The self feeding of coal and the increased



Smokebox Front Mounted on Hinge to Permit of Easy Access to the Front End

water capacity eliminate water and coal stops and there is no bad coal left as an accumulation in the tank.

The following table gives the principal dimensions and ratios of these locomotives:

General Data

Gage	4 ft. 8½ in.
Service	Switching
Fuel	Bit. coal
Tractive effort	47,200 lb.
Weight in working order	220,000 lb.
Weight of engine and tender in working order	380,000 lb.
Wheel base, driving	16 ft. 0 in.
Wheel base, engine and tender	54 ft. 3 in.

Ratios

Weight on drivers ÷ tractive effort	4.66
Tractive effort × diam. drivers ÷ equivalent heating surface*	780.5
Equivalent heating surface* ÷ grate area	68.7
Firebox heating surface ÷ equivalent heating surface,* per cent	5.6
Weight on drivers ÷ equivalent heating surface*	63.8
Volume both cylinders	14.42 cu. ft.
Equivalent heating surface* ÷ vol. cylinders	239.0
Grate area ÷ vol. cylinders	3.48

Cylinders

Kind	Simple
Diameter and stroke	23 in. by 30 in.

Valves

Kind	Piston
Diameter	12 in.
Greatest travel	6 in.
Outside lap	1 in.

Wheels

Driving diameter over tires	57 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	10 in. by 14 in.
Driving journals, others, diameter and length	9½ in. by 12 in.

Boiler

Style	Straight top, wide firebox
Working pressure	200 lb. per sq. in.
Outside diameter of first ring	74¾ in.
Firebox, length and width	96⅛ in. by 75¼ in.
Firebox plates, thickness	½ in.
Firebox, water space	4½ in.
Tubes, number and outside diameter	177—2 in.
Flues, number and outside diameter	30—5⅜ in.
Tubes and flues, length	18 ft. 0 in.
Heating surface, tubes and flues	2,428 sq. ft.
Heating surface, firebox and arch tubes	193 sq. ft.
Heating surface, total	2,621 sq. ft.
Superheater heating surface	551 sq. ft.
Equivalent heating surface*	3,447 sq. ft.
Grate area	502 sq. ft.

Tender

Tank	Water bottom, conical hopper
Weight	160,000 lb.
Wheels, diameter	36 in.
Journals, diameter and length	5½ in. by 10 in.
Water capacity	9,000 gal.
Coal capacity	12 tons

*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.

A LOCOMOTIVE REPAIR SHOP OUTPUT SCHEDULE

BY H. L. BURRHUS

Is it possible to rate locomotive repairs on a manufacturing basis and figure output at a regular stated amount per month? In the past the answer to this question has been that the nature of repairs varies so much that it is impossible to place any specified shop time on a locomotive when it receives general repairs.

There was a time when one shop would claim to handle 40 locomotives a month while some other shop could only boast of 30, yet the shop which turned out the 30 locomotives actually did more work, for they counted only such engines as received a general overhauling as an engine out of shop, while the shop which claimed the 40 engines as a month's output would charge every class of repairs as "general." Now that all shops are using the same unit of measure to classify repairs we can compare the output of shops with greater accuracy. As all shops are paying their workmen on a day work basis, conditions are even more comparable, and any wide variance found in shop output must be due to the shop system or facilities.

Man effort is the same in the east as in the west, hence the shop equipment and system are the deciding factors in the maintenance or the building up of shop output. If several shops have different scheduling systems, the reason why one shop exceeds in output is that their system is better in preventing loss of time and waste of man power.

There are many shop scheduling systems in use which are giving good results, but as a rule they require the services of several clerks and considerable book or card keeping. A system which can be handled by the foremen without adding to their already numerous duties would be desirable, and as we look to the initiative and judgment of the supervising forces to carry out any system, we should not burden a foreman with additional clerical duties.

As cost of repairs, shop time and working schedules are all based on hourly time, it is practicable to develop an "hourly period system."

Before going into the details of this proposed system, let us see how the "shop schedule system" compares with the "hourly period system." If the shop schedule system has been developed on the basis of a ten-hour day and the shop working period is reduced to eight hours a day, the system is entirely disorganized, and if some unlooked for holiday is granted, the schedule is upset. The hourly system period, being based on the one-hour period, is flexible and covers these conditions irrespective of the number of hours worked each day.

It may be claimed that a shop schedule system is not based on the time taken to complete operations, but to see that operations are completed in a specified order so that work in the erecting department will follow in proper sequence. Such a system is at fault in that there may be many lapses of time

between the delivery of finished parts, hence any workable shop schedule is a time system, irrespective of the system adopted and the elimination of a vast amount of detail is provided for when a final date is given for an engine to leave the shop. If an engine is marked up to go out of the shop on the fifteenth of the month, that one date is the summary of every item of detail which the various departments should provide for.

With the hourly period system, if the class of repairs requires 120 shop hours and every foreman knows the number of hours he is allowed for his portion of the job, he needs no card record or follow up system to see that his particular part is delivered on time.

Shop conditions naturally affect the number of working hours required to overhaul an engine. In a shop where the stripping is handled by a special stripping gang we find it is possible for 15 men to strip an engine in one 10-hour day or 150 work hours. If, as often happens, this gang is short a few men there should be no failure to complete the stripping on time as the number of man hours necessary to strip an engine is known to be 150 hours whether it be 15 men working 10 hours or 10 men working 15 hours. It is easy to lose sight of time when an engine first comes in the shop but this is the critical period and the time to rush repairs is at first—not the last few days.

When the shop is placed on an eight-hour working day we find that the original gang of 15 men makes a total of 120 effort hours a day, or 30 hours less than the required time, thus reducing the output of this gang to one engine less every five days.

To establish such a system we must depend on the experience and support of the foremen. To say that a foreman has no idea of the time required by his department to complete certain operations, is to admit that the selection of such a supervising officer has been at fault.

The foreman of a shop handling driving wheels had no system to get out his work and he usually started the heaviest jobs first, for he prided himself on turning out heavy jobs in a short time. He would turn tires and take care of crank pins first and in the meantime the boring and facing of the driving boxes would be held up.

A time schedule of 40 hours was placed on this work as follows: 15 hours from the end of stripping time to the completion of journal truing; 20 hours to completion of crank pins and 40 hours from the end of stripping time to the time the completed set of driving wheels was delivered to the erecting gang. This arrangement allowed for driving boxes being bored and faced so that at the end of 40 hours after stripping they also were delivered to the erecting gang. The foremen soon learned to watch the stripping pit to see what they would have to do on their particular parts of the work. As the wheels were dropped shortly after stripping began, the driving box foreman could note if any new boxes were required and it was not unusual to have new boxes brought in from the storehouse and machine work started by noon on the day an engine was being stripped. By nine o'clock the wheel foreman had checked the crank pins so that orders for material were placed fully eight hours before his working time period began.

The hourly period system required a set of driving wheels to be delivered ready for application in 40 hours. The foreman of the wheel department could meet this demand by working his entire force on one set of wheels but in the meantime, the stripping gang had delivered another set of wheels which was also due to leave the department in 40 hours.

The wheel shop was tied up tight and the hourly system period showed up the faults at once as it was found that this foreman did not keep his men regularly on one job. A mechanic would start to turn journals, then go to the tire lathe and then perhaps turn a new axle, but by assigning men to regular jobs and planning to keep the work coming to them in stated quantities it was soon found that wheels could be delivered to meet the requirements.

After checking up the driving box work and placing 40 hours as the time limit to complete a set of boxes it was found that certain conditions in this department delayed the work. Because of a rough floor two men were required to a truck instead of one and the extra man did not have steady work. This condition was corrected. Depending on the busy overhead electric crane caused many delays, so an individual crane was installed. The arrangement for pressing out and pressing in brasses was very unhandy and at a slight expense a press was installed so that these time delays were eliminated. These and many other things, unnoticed before, were brought out when the foreman was required to deliver a set of finished boxes 40 hours after he received them.

Ask any erecting foreman how long it will take him to put out an engine and he will tell you so many hours after he receives the wheels and boxes and other fittings and he needs no card system to follow up his work. Keep him supplied with finished work from the various shops and he will keep his date—or as is often the case—reduce the time an hour or two.

When the engine has been delivered to the erecting pit, parts such as spring rigging, shoes and wedges and other parts handled by the erecting gang are also delivered at the same time and we now start on our hourly period system to handle these parts. Spring rigging has been scheduled for a 50-hour period, subdivided as follows: Five hours, after completion of stripping, to be inspected and parts delivered to various departments for attention; 15 hours from the end of this period all forging and blacksmith work to be completed in order to allow 20 hours for laying out and to have machinework done. This allows 10 hours to apply the parts to the engine and as several parts have already been returned, these final 10 hours are ample to complete application ready for wheeling. Seventy-five hours from the time the engine has been delivered to the erecting pit, the wheels have been applied, trammed, and are ready for the application of the motion work and for valve setting. Twenty hours from this period is allowed for the completion of valve setting. In the meantime the flues have been applied and the boiler shop forces, working on an hourly period system have carried their work along so that the boiler test can be applied 80 hours after the engine has been stripped.

Allowing 35 hours to complete the engine after the valves have been set we find that the engine has gone through the shop in a total of 140 hours. This may seem a rather long period, but these figures are given for a modern heavy locomotive and are taken from averages.

It was found that it had been taking practically two weeks to get a set of eccentrics through the machine department, but with the hourly time period this was reduced to 40 hours from the completion of the stripping period to the delivery of the eccentrics to the erecting shop ready for application. Machines which had been idle were put in commission to insure a steady flow of finished machine jobs to the fitting and erecting shops, and after all, it is the steady and regular return of such parts that governs shop output.

When regulated in this manner the shop output was increased nearly 100 per cent with less workmen, and as there were still many items to be corrected, the output could be increased over this figure. While it had been possible in some special cases to turn two engines per month off the same pit, it was found that to do so, some other engine was being neglected, and the desired regular output was obtained by adhering strictly to the hourly period system.

The wheel gang instead of finishing one set of wheels today and then skipping two or three days before delivering other finished wheels to the erecting shop, has been developed so that they give a set of finished wheels just as fast as the stripping gang strips an engine. The driving box gang can

average a set of boxes in 10 hours, though we find that each workman only averages about seven hours per set. The reason for this is that much roundhouse work, for which provision must be made, is handled by this gang.

Today all locomotive repair work is heavy and a working schedule should take this important item into consideration. The day when one man could lift a driving box onto the journal is past, and shop equipment should be provided to save man power.

When the question of output requirements is considered, the benefit of this system to the higher officers is apparent, as they have the complete possibilities before them in a table showing the total work hours required for each type of engine and each class of repairs.

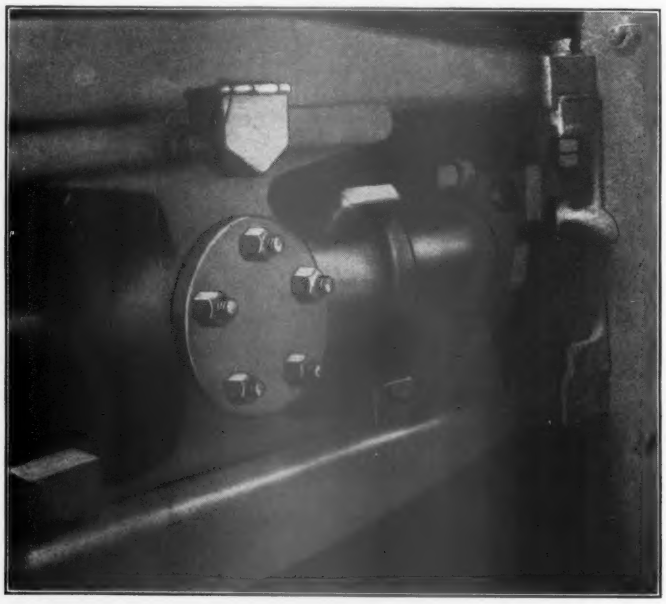
A good system without a mass of detail to follow will make the work easier for the men, simplify the duties of the foremen and practically double the output.

In making up any system, do not lose sight of what constitutes a fair day's work. Strike an average fair to the workmen and fair to the employer and the workmen will take pride in keeping their department on the honor roll. And as a word of caution, the man selected for the establishing of any system should be transferred from another shop, as a man selected to install a system in his own shop is likely to ignore certain points which might have great influence on its success.

CROSSHEAD PIN ON RUSSIAN BUILT LOCOMOTIVES

BY LIEUT. JAMES GRANT
Russian Railway Service Corps., American Expeditionary Forces in Siberia

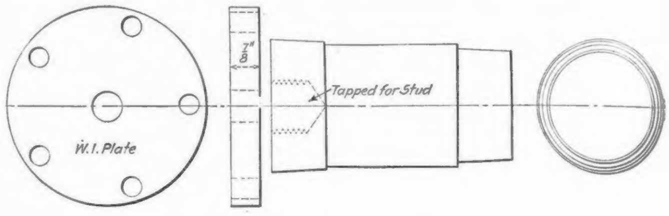
The accompanying sketch and photograph show a design of crosshead pin in general use on Russian built locomotives. This style of pin has some advantages over the one so commonly used on American locomotives, and is probably easier to make and apply. The crosshead is bored with the large



The Crosshead Pin Applied

end of the taper to the outside, so that the pin is applied from the outer side of the guides. On most American locomotives the pin is applied from the inside, and it is quite a difficult operation for a mechanic to reach behind the guide bars and apply the heavy pins that are now used on large locomotives.

Another advantage is that it is securely held in place by a neatly machined plate, with five ⅞-in. studs. On American locomotives the pin is drawn and held in place by large nuts, which necessitate enormous wrenches and consequent difficulty in drawing the pin tight.



Details of the Russian Crosshead Pin

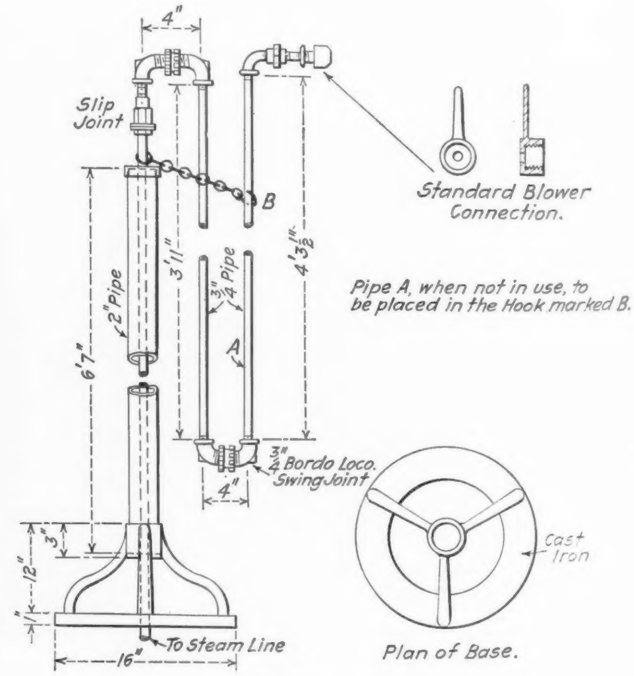
Provision is made for extracting the pin by a 1½-in. hole, tapped in its center so that it can be easily pulled with a plate and a stud.

BLOWER PIPE STAND FOR ROUNDHOUSES

BY E. A. MILLER

A blower pipe stand has been devised for use in roundhouses which has proved to be very convenient for quickly connecting up the blower to engines that have just been fired.

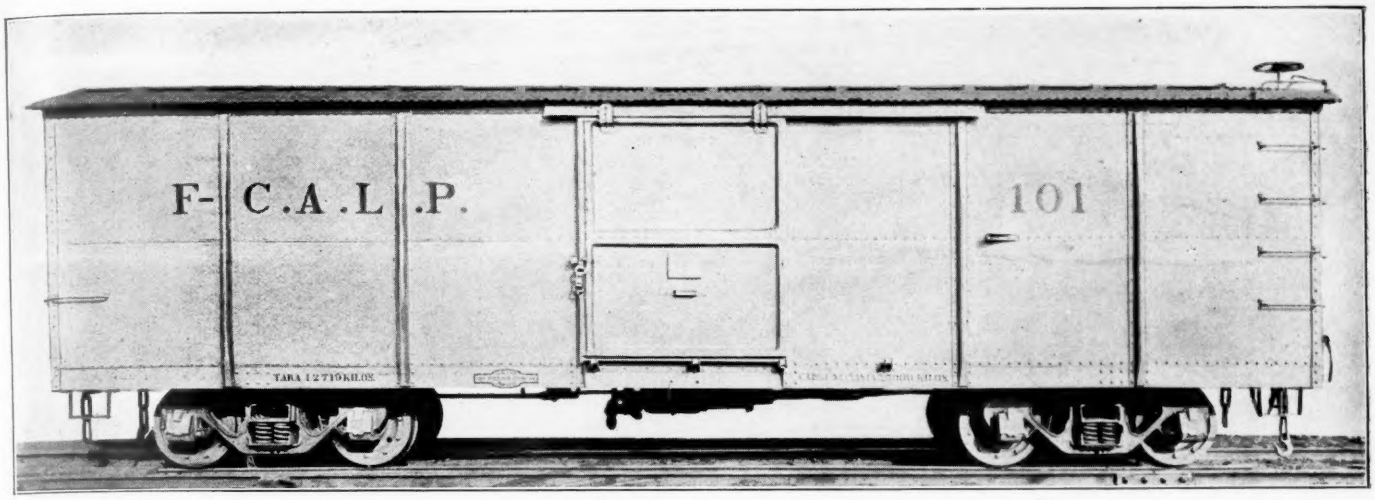
The stand consists of a cast iron base holding a 2 in. wrought iron pipe through which passes a ¾ in. pipe connected with the steam line. Other pipes with elbows, unions and swing joints are installed to give the scope necessary and a standard blower connection is attached to the outer



The Stand with Piping Held by the Chain

end. These stands are placed between the stalls in a roundhouse so that the device may be connected to the blower on either side. The 2 in. wrought iron pipe serves as a stand for the steam piping and at the same time affords protection against being burned to any one who might otherwise come in contact with the heated pipes.

When the device is not in use it can be swung back and held close to the stand by the chain, as shown in the illustration.



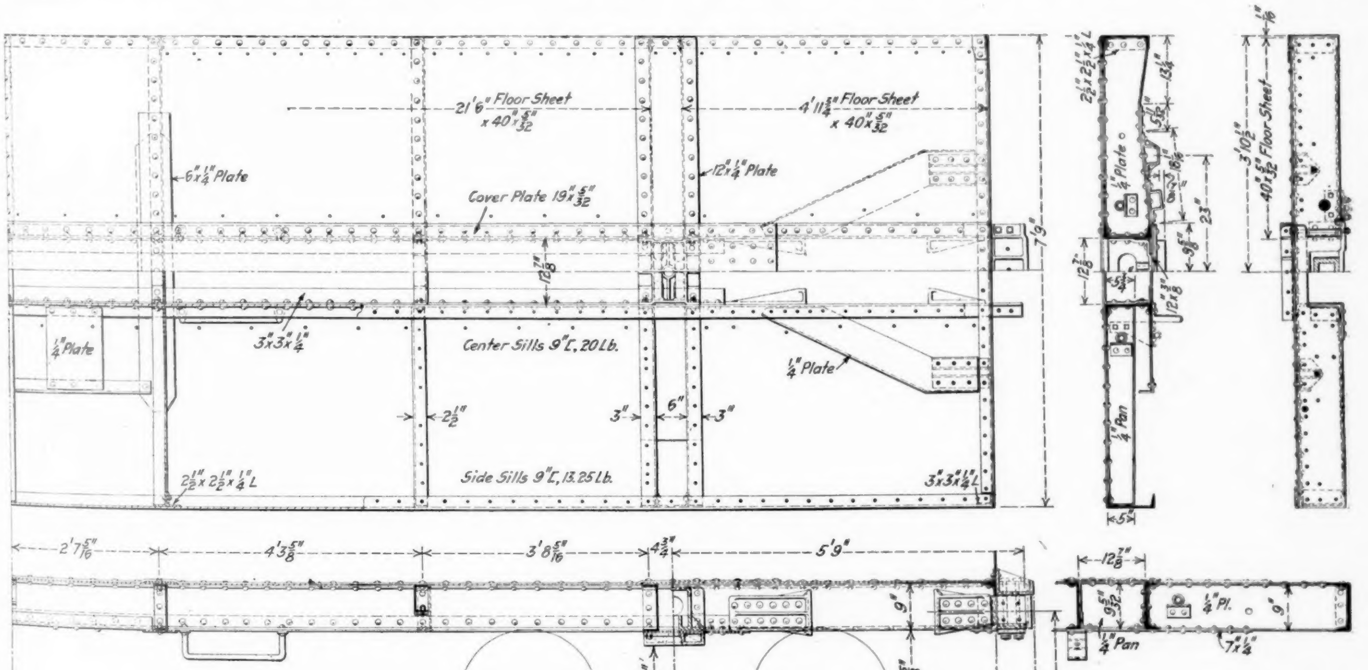
Narrow Gage Steel Box Car for Use in Chile

Box Cars For Chilean Railway

Steel Construction of American Type for Meter Gage Line, Including M. C. B. Couplers and Trucks

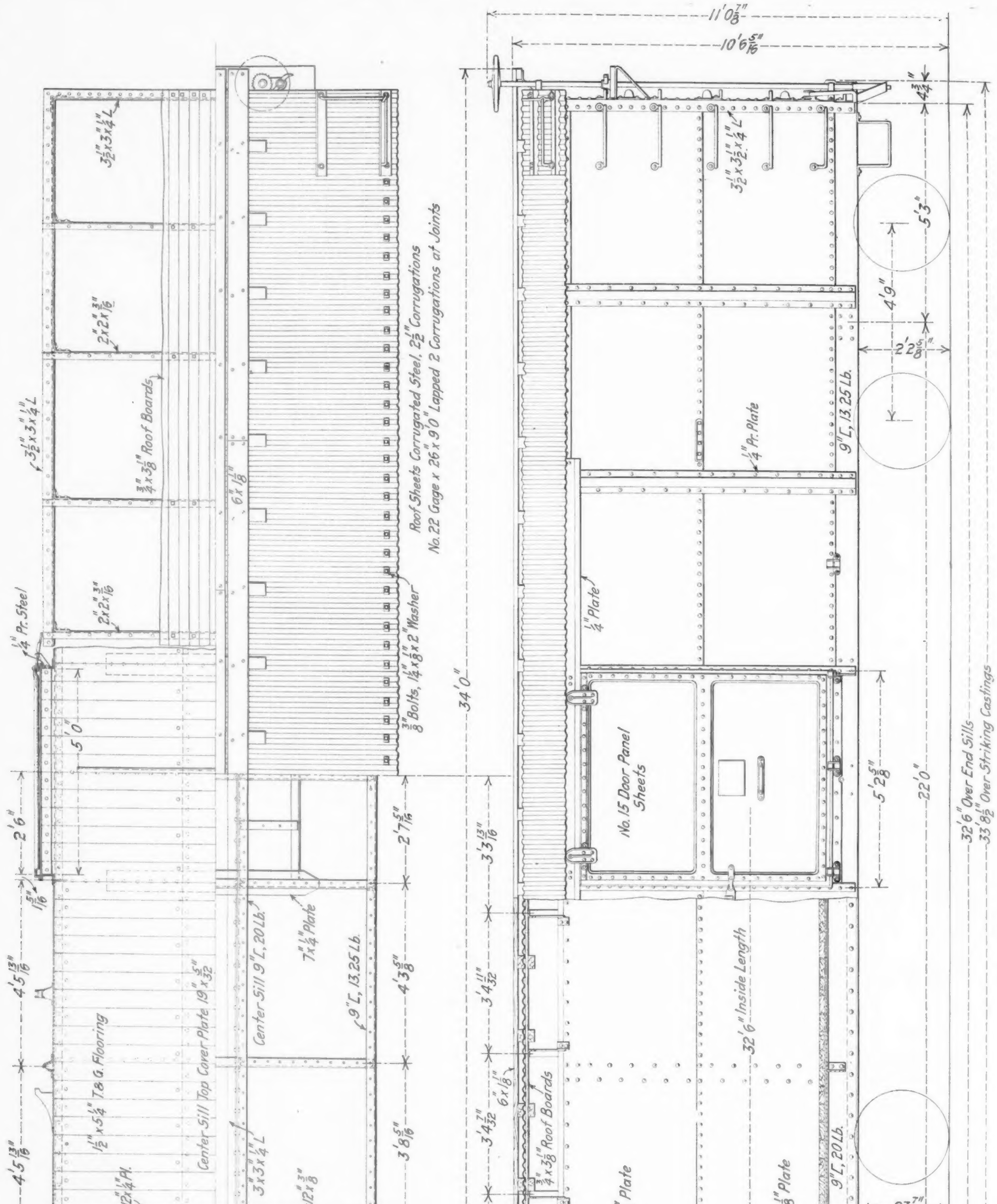
The Arica-La Paz Railroad, part of the Chilean Government system, has recently received from the Pullman, Ill., works of the Pullman Company an order of 100 steel box cars for operation on a meter gage line. These cars will be found of interest to American readers because of the extent to which American standards and types of design have been embodied in them, as well as because of several interesting features not usually incorporated in the design of cars for use on this continent.

These cars have a rated capacity of 25,000 kilos, or 55,000 lb., and have a light weight of 12,719 kilos, or 28,000 lb. The principal dimensions are, length inside, 32 ft. 6 in.; width inside, 7 ft. 9 in.; height, 6 ft. 2 3/16 in. from the top of the sill to the plate; height, rail to top of running board, 10 ft. 6 5/16 in.; height, rail to center of drawbar, 2 ft. 6 in., and distance center to center of trucks, 22 ft. The transverse contour of the roof is circular and the height under the carline at the center of the car is 6 ft. 11 3/32 in. The cars have the customary arrangement of side doors, which are about 5 ft. wide by 5 ft. 10 in. high. The cars are practically of steel construction throughout.



Underframe of the Narrow Gage Box Car

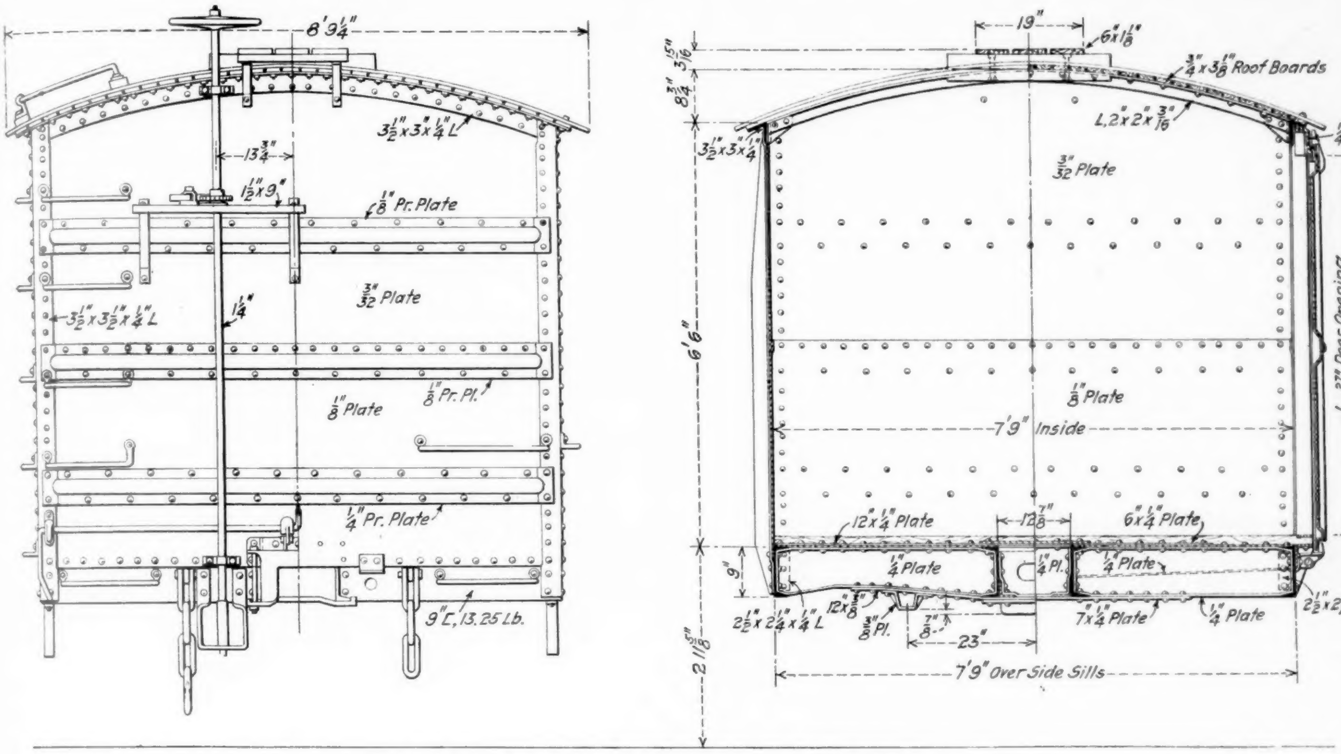
The main members of the underframe are of structural



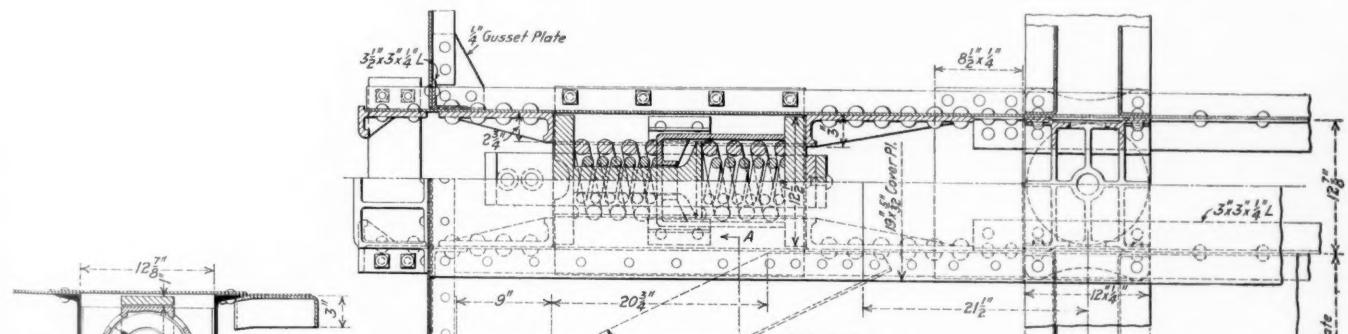
Plan and Elevation of the Arica-La Paz Steel Box Car

section with bolsters and intermediate diaphragms of pressed steel. The center sills are of 9-in., 20-lb. channel section while the side sills are 9-in., 13.25 lb. channels. The center sills are placed back to back with a spacing of 12⅞ in. and have a top cover plate of 5/32-in. material, 19 in. wide, which extends continuously between points 21½ in. toward the ends of the car from the center line of the bolsters.

The bolsters are of the double plate type and are built up of two pressed steel channel sections placed 6 in. back to back, with a filler casting between the center sills. A ¼-in. top cover plate 12 in. wide, extending continuously across the car, is riveted to the top flanges of the web members. The bolsters are completed by a bottom cover plate ⅜ in. thick, extending across the center sills to points 13¼ in. from the face of the side sills. A 5/32-in. plate is riveted to the top flanges of the center sills between the bolster cover plate and the end sills.



End Elevation and Half Sections of the Chilean Box Car



Twin Spring Draft Gear Arranged in Tandem

There are four intermediate diaphragms. The two

center diaphragms are located in line with the side door posts and are of single plate pressed steel section with a uniform depth of nine inches. Both top and bottom flanges are reinforced with 1/4-in. plates which extend only part way across the car. The top plate is six inches wide while the lower one is seven inches wide. The other two diaphragms are also of the single plate type of 1/4-in. pressed channel section but have a uniform depth of only five inches. These are about five feet inside of the center of the bolsters.

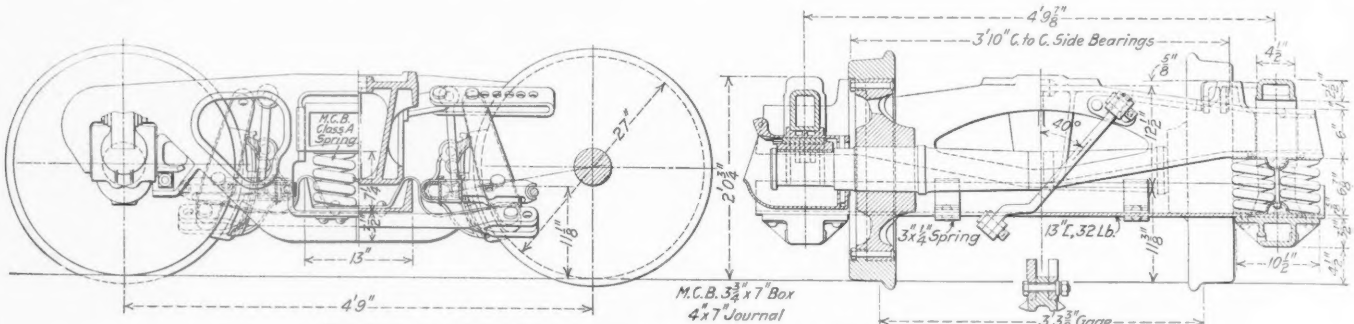
One of the interesting features of this design is the draft gear, which in general is of the type ordinarily used in America, but involves an unusual arrangement of the draft springs. In principle the gear is of the twin spring type, but the springs are arranged in tandem. The direct action of the two springs is secured by an ingenious arrangement of sleeve and spool, which carries the reaction of each spring directly from one follower plate to the other. The forward spring is slipped over a spool, the rear end of which bears against the forward end of the rear spring, thus carrying the forward reaction of the rear spring directly against the forward follower plate. The backward reaction of the forward spring is similarly carried to the rear follower plate by means of a spool which encircles the rear spring.

The body is made up of 3½-in. by 3½in. by 1/4-in. angle corner posts, channel section door posts of 1/4-in. pressed steel and four special flanged U-section intermediate posts on each side of the car. The steel sheathing on the sides and ends of the car are laid in two courses which are joined with a lap joint. The upper course is of 3/32-in. plate while the plate in the lower course is 1/8-in. thick. The ends of the car are reinforced with three flanged U-section steel pressings, placed horizontally.

The carlines are 2-in. by 2-in. by 3/16-in. angles, the horizontal flanges of which are riveted to the tops of the 3½-in. by 3-in. by 1/4-in. angle side plates. The roof is surfaced with corrugated steel sheets of No. 22 gage material, which is laid over a course of 3/4-in. by 3 1/8-in. longitudinal roof boards bolted to the carlines. These sheets are secured near the eaves by 3/8-in. bolts, which pass through the horizontal flange of the side plate and the outside roof boards. The entire underframe is covered with 5/32-in. steel plates on which the floor is laid. The floor is of 1½-in. tongued and grooved yellow pine material.

The truck is of the Buckeye pedestal type for 3-ft. 3 3/8-in. track gage and has a wheel base of 4 ft. 9 in. The wheels are steel tired on cast iron centers and are 27 in. in diameter. They are mounted on axles with 4-in. by 7-in. journals which run in M. C. B. standard 3 3/4-in. by 7-in. journal boxes. The cast steel bolster is carried on M. C. B. class *A* springs. The truck has a height of center plate under load of 23 7/8 in.

The cars are equipped with M. C. B. type automatic couplers and in addition are provided with safety chains on either side of the drawbar. The cars are fitted with ladders and grab irons, practically in accordance with American practice. Westinghouse automatic air brakes, schedule HC-812, are used on these cars, and in addition they are provided with an auxiliary train line for direct control of brake pressure from the locomotive, with the pressure retaining valve cut out.



Buckeye Narrow Gage Pedestal Truck for the Arica-La Paz Box Cars

THE LONGITUDINAL DISTURBING FORCES IN LOCOMOTIVES

BY EDWARD L COSTER
Assoc. Am. Soc. M. E.

In the American Engineer and Railroad Journal for December, 1905, there appeared an article by the present writer entitled "Comparative Magnitude of Longitudinal Disturbing Forces in a Cole Balanced Compound and a Single Expansion Express Locomotive," in which several important formulae were presented, but their derivation was not explained. It is the object of the present paper to derive these

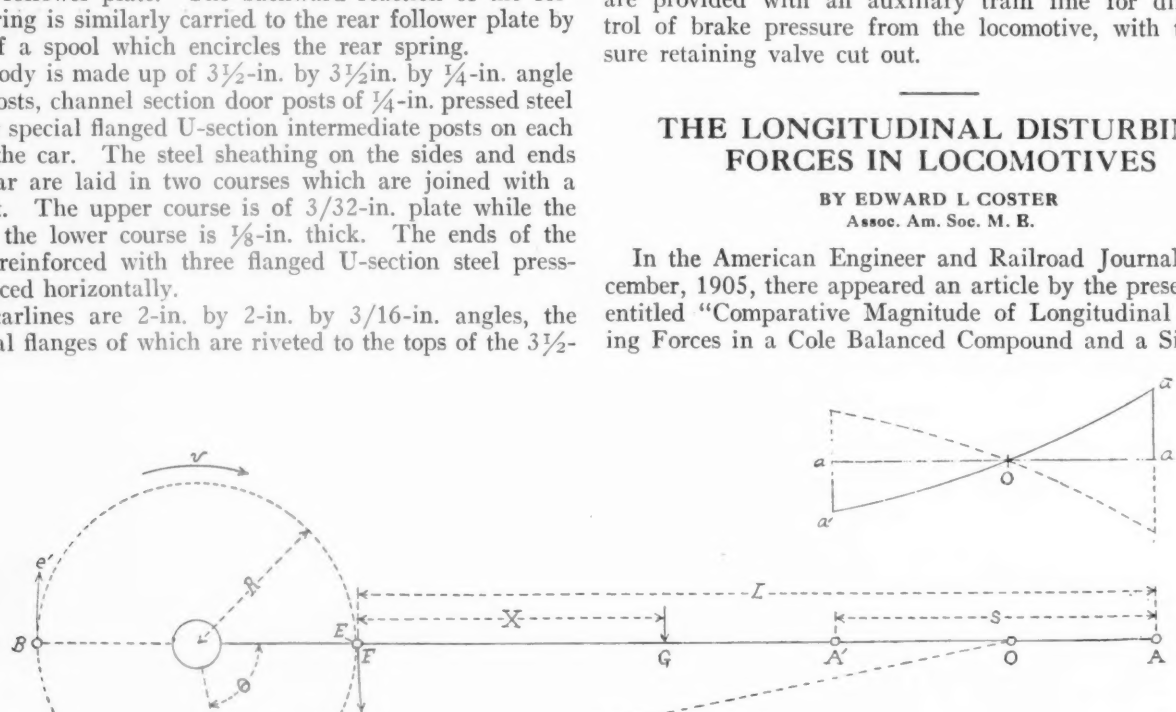


Diagram on Which Discussion Is Based.

formulae in the simplest possible manner, without the use of the higher mathematics which are usually employed for this purpose. The practical application of these formulae is illustrated in the article above referred to.

In the diagram, let *F* and *B* denote the front and back dead points, respectively.

Let s = piston stroke in inches.
D = driving wheel diameter in inches.
R, r, = crank radius in feet and inches, respectively.
L, l, = length of connecting rod in feet and inches, respectively.
X, x, = distance of center of gravity, G, of connecting rod from crank pin center in feet and inches, respectively.
W = weight of unbalanced revolving parts (if any) in pounds.
W' = weight of reciprocating parts in pounds.
W'' = weight of connecting rod in pounds.
V = speed in miles per hour.
v = uniform crank pin velocity in feet per second.
P = horizontal inertia of unbalanced revolving parts at *F* and *B* in pounds.
P'_f = inertia of reciprocating parts at *F* in pounds.
P'_b = inertia of reciprocating parts at *B* in pounds.
P''_f = horizontal inertia of connecting rod at *F* in pounds.
P''_b = horizontal inertia of connecting rod at *B* in pounds.
C = centrifugal force of connecting rod at *F* and *B* in pounds.
g = gravitational acceleration = 32.16 ft. per sec. per sec.

Since the centripetal acceleration of the crank pin is $\frac{v^2}{R}$ ft. per sec. per sec.

$$P = \frac{Wv^2}{gR}.$$

$$\text{But } \frac{v^2}{gR} = \frac{\left\{2\pi\frac{r}{12} \times \frac{5280V \times 12}{\pi D \times 60^2}\right\}^2}{32.16\frac{r}{12}} = \frac{8.602r^2\frac{V^2}{D^2}}{2.68r} = 3.2r\frac{V^2}{D^2} = 1.6s\frac{V^2}{D^2}$$

$$\text{Therefore } P = 3.2Wr\frac{V^2}{D^2} = 1.6Ws\frac{V^2}{D^2} \quad \ldots\ldots(1)$$

At "diameter speed," $V = D$, hence for this case

$$P = 3.2Wr = 1.6Ws \quad \ldots\ldots(1a)$$

$$\text{For } L = \text{infinity, } P'_f = P'_b = \frac{W'v^2}{gR}$$

But for a finite connecting rod, as the crank pin passes *F*, the center point, *E*, of the rod's crank pin bearing, describes an infinitely small arc of a circle, *e*, about the axis of the cross-head pin *A*. The circumferential velocity of *E* is v, and if $L = nR$, the forward (centripetal) acceleration of *E* is $\frac{v^2}{nR}$ ft. per sec. per sec. But the backward acceleration of the crank pin is $\frac{v^2}{R}$; hence, since *E* is constrained to travel in the crank pin path, its total backward acceleration, and therefore that of *A* and the reciprocating parts, is

$$\frac{v^2}{R} + \frac{v^2}{nR} = \frac{v^2}{R}\left\{1 + \frac{1}{n}\right\} = \frac{v^2}{R}\left\{1 + \frac{R}{nR}\right\} = \frac{v^2}{R}\left\{1 + \frac{R}{L}\right\}$$

Therefore:

$$P'_f = \frac{W'v^2}{gR}\left\{1 + \frac{R}{L}\right\} = 3.2W'r\frac{V^2}{D^2}\left\{1 + \frac{r}{l}\right\} = 1.6W's\frac{V^2}{D^2}\left\{1 + \frac{r}{l}\right\} \quad ..(2)$$

and at diameter speed:

$$P'_f = 3.2W'r\left\{1 + \frac{r}{l}\right\} = 1.6W's\left\{1 + \frac{r}{l}\right\} \quad \ldots\ldots(2a)$$

As the crank pin passes *B*, the point *E* again describes an infinitely small circular arc, *e'*, about *A'*, the forward acceleration of *E* being $\frac{v^2}{nR}$ as before. But since the direction of this acceleration is now the same as that of the crank pin, the resultant forward acceleration of *E*, and therefore that of *A'* and the reciprocating parts is:

$$\frac{v^2}{R} - \frac{v^2}{nR} = \frac{v^2}{R}\left\{1 - \frac{1}{n}\right\} = \frac{v^2}{R}\left\{1 - \frac{R}{nR}\right\} = \frac{v^2}{R}\left\{1 - \frac{R}{L}\right\}$$

Therefore:

$$P'_b = \frac{W'v^2}{gR}\left\{1 - \frac{R}{L}\right\} = 3.2W'r\frac{V^2}{D^2}\left\{1 - \frac{r}{l}\right\} = 1.6W's\frac{V^2}{D^2}\left\{1 - \frac{r}{l}\right\} \quad \ldots(3)$$

and at diameter speed:

$$P'_b = 3.2W'r\left\{1 - \frac{r}{l}\right\} = 1.6W's\left\{1 - \frac{r}{l}\right\} \quad \ldots\ldots(3a)$$

As the crank pin passes *F* and *B*, the center of gravity, *G*, of the connecting rod attains its maximum circumferential velocity of $v\frac{L - X}{L}$ ft. per sec. about *A* and *A'*, respectively; hence at these points the forward (centripetal) acceleration of *G* is:

$$\frac{\left\{v\frac{L - X}{L}\right\}^2}{L - X} = \frac{v^2(L - X)^2}{(L - X)L^2} = \frac{v^2(L - X)}{L^2} \text{ ft. per sec. per sec.}$$

But at *F* the backward acceleration of *A* is $\frac{v^2}{R}\left\{1 + \frac{R}{L}\right\}$ therefore the resultant backward acceleration of *G* is:

$$\frac{v^2}{R}\left\{1 + \frac{R}{L}\right\} - \frac{v^2(L - X)}{L^2}$$

At *B* the forward acceleration of A' is $\frac{v^2}{R}\left\{1 - \frac{R}{L}\right\}$, therefore total forward acceleration of *G* is:

$$\frac{v^2}{R}\left\{1 - \frac{R}{L}\right\} + \frac{v^2(L - X)}{L^2}$$

Consequently the general expression for the maximum horizontal acceleration of *G* in feet per second per second, is:

$$\frac{v^2}{R}\left\{1 \pm \frac{R}{L}\right\} \mp \frac{v^2(L - X)}{L^2}$$

the upper and lower signs corresponding to the front and back dead points, respectively. Thus by reducing we have:

$$\frac{v^2}{R}\left\{1 \pm \frac{R}{L}\right\} \mp \frac{v^2(L - X)}{L^2} = \frac{v^2}{R} \pm \frac{v^2R}{RL} \mp \frac{v^2L}{L^2} \pm \frac{v^2X}{L^2} = \frac{v^2L^2}{RL^2}$$
$$\pm \frac{v^2RL^2}{RL^3} \mp \frac{v^2LR}{RL^2} \pm \frac{v^2XR}{RL^2} = \frac{v^2L^2}{RL^2} \pm \frac{v^2RL}{RL^2} \mp \frac{v^2RL}{RL^2} \pm \frac{v^2XR}{RL^2} =$$
$$\frac{v^2L^2 \pm v^2XR}{RL^2} = \frac{R}{v^2}\left\{\frac{L^2 \pm XR}{L^2}\right\} = \frac{v^2}{R}\left\{1 \pm \frac{XR}{L^2}\right\}$$

Hence

$$P''_f = \frac{W''v^2}{gR}\left\{1 + \frac{XR}{L^2}\right\} = 3.2W''r\frac{V^2}{D^2}\left\{1 + \frac{xr}{l^2}\right\} = 1.6W''s\frac{V^2}{D^2}\left\{1 + \frac{xr}{l^2}\right\} \quad .(4)$$

and at diameter speed

$$P''_f = 3.2W''r\left\{1 + \frac{xr}{l^2}\right\} = 1.6W''s\left\{1 + \frac{xr}{l^2}\right\} \quad \ldots\ldots(4a)$$

$$P''_b = \frac{W''v^2}{gR}\left\{1 - \frac{XR}{L^2}\right\} = 3.2W''r\frac{V^2}{D^2}\left\{1 - \frac{xr}{l^2}\right\} = 1.6W''s\frac{V^2}{D^2}\left\{1 - \frac{xr}{l^2}\right\} \quad \ldots(5)$$

and at diameter speed

$$P''_b = 3.2W''r\left\{1 - \frac{xr}{l^2}\right\} = 1.6W''s\left\{1 - \frac{xr}{l^2}\right\} \quad \ldots\ldots(5a)$$

Equations 4 and 5 indicate that the horizontal inertia of the connecting rod is increased at *F* and diminished at *B* by a quantity $\frac{W''v^2}{gR} \times \frac{XR}{L^2}$, whose direction of action is forward in both cases, it appearing under the negative sign in equation 5 as the main force of inertia in this case is really negative, as it acts backward. Hence, since at both dead points the centrifugal force of the connecting rod, $C = \frac{W''v^2(L - X)}{gL^2}$, acts backward, it tends to neutralize this irregularity. Thus:

$$\frac{W''v^2}{gR} \times \frac{XR}{L^2} - \frac{W''v^2(L - X)}{gL^2} = \frac{W''v^2}{gR} \times \frac{XR}{L^2} - \frac{W''v^2}{gR} \times \frac{R(L - X)}{L^2} = \frac{W''v^2}{gR}$$
$$\left\{\frac{XR}{L^2} - \frac{R(L - X)}{L^2}\right\} = \frac{W''v^2}{gR}\left\{\frac{XR - RL + XR}{L^2}\right\} = \frac{W''v^2}{gR} \times R\frac{2X - L}{L^2},$$

which is the difference between the two forces, or the amount that is not neutralized. Complete neutralization evidently requires that $R\frac{2X - L}{L^2} = 0$, for which condition $2X = L$, or $X = \frac{L}{2}$; i. e. *G* must be at the center of the connecting rod. If it be nearer *E*, as is always the case, $2X < L$, and the result is negative, or *C* more than neutralizes the irregularity of the horizontal inertia of the rod.*

Consequently, when the effect of *C* is included,

$$P''_f = \frac{W''v^2}{gR}\left\{1 + R\frac{2X - L}{L^2}\right\} = 3.2W''r\frac{V^2}{D^2}\left\{1 + r\frac{2x - l}{l^2}\right\} = 1.6W''s\frac{V^2}{D^2}$$
$$\left\{1 + r\frac{2x - l}{l^2}\right\} \quad \ldots\ldots(6)$$

and at diameter speed:

*See Henderson's "Locomotive Operation," 2nd edition, pp. 39-41.

$$P''_f = 3.2W''r\left\{1 + r\frac{2x-1}{l^2}\right\} = 1.6W''s\left\{1 + r\frac{2x-1}{l^2}\right\} \text{.........(6a)}$$

$$P''_b = \frac{W''v^2}{gR}\left\{1 - R\frac{2X-L}{L^2}\right\} = 3.2W''r\frac{V^2}{D^2}\left\{1 - r\frac{2x-1}{l^2}\right\}$$

$$= 1.6W''s\frac{V^2}{D^2}\left\{1 - r\frac{2x-1}{l^2}\right\} \text{............(7)}$$

and at diameter speed

$$P''_b = 3.2W''r\left\{1 - r\frac{2x-1}{l^2}\right\} = 1.6W''s\left\{1 - r\frac{2x-1}{l^2}\right\} \text{....(7a)}$$

For the values of $\frac{L}{R}$ obtaining in locomotive practice, the point *O*, of maximum horizontal velocity and consequent zero acceleration of both the reciprocating parts and the center of gravity of the connecting rod, corresponds very approximately to the position in which the axis of the rod is normal to the crank, i. e., when $AO = R + L - \sqrt{L^2 - R^2}$, and the crank angle, θ, is that whose tangent $= \frac{L}{R}$. Hence if we so locate point *O* either on the atmospheric line of a pair of superimposed indicator diagrams, or the base line of a net piston pressure diagram, which lines are represented by *aa'*; from the extremities of this line lay off to the scale of the indicator spring, the vertical distances *aa* and *a'a'*, equal respectively to $P'_f + P''_f$, and $P'_b + P''_b$, per square inch of effective piston area, and describe a circular arc through the points *aoa'*, then *aoa'* represents with quite sufficient accuracy for most practical purposes the curve of horizontal inertia of the reciprocating parts and connecting rod with which to correct the indicator, or effective pressure diagrams, when determining the force transmitted to the crank pin during the backward stroke. For the forward stroke, the inertia curve (shown dotted) is of course simply the reflection of the curve *aoa'*.

TEAMWORK OF ENGINEMEN AND FIREMEN*

BY M. A. DALY
General Fuel Supervisor, Northern Pacific

Engine crews dispose of nearly all of the coal used on the railroads of the United States. Approximately 95 per cent of all railroad coal passes through their hands. Nearly 130,000,000 tons of coal will this year be mined, hauled and placed on the tenders of locomotives. Into the fireboxes about $434,000,000 worth of coal will be shoveled.

Some of the coal mined for the locomotives will not be delivered to the tenders, some of the coal delivered to the tenders will not be thrown into the fireboxes, and some thrown into the fireboxes will not be burned. Coal will be lost from cars en route from mines to coal docks, coal will be lost off the side rails, decks and end sills of the tenders, and unburned coal will be lost through the grates and through the smokestacks. A large percentage of those losses are avoidable. Just how much, however, may always be an unknown quantity. Nevertheless, many railroads are now recognizing that such losses are enormous, and that partial prevention is easily possible.

The value of a ton of coal may be carelessly considered in railroad operation, but the cost of each ton will inevitably take its deliberate bite out of the current operating revenues. Each morning in the United States 65,000 locomotives stand ready for service. At the close of each day $1,190,000 worth of locomotive coal has been turned to ashes. Every ton of the coal contains a definite amount of potential draw-bar-pull. How much of it is actually utilized in pulling cars will depend largely on the condition of the locomotive, the manner in which it is operated, and the skill with which the coal is placed on the firebed.

*Abstract of a paper presented before the Convention of the International Railway Fuel Association at Chicago, May 19-22, 1919.

When a locomotive is properly maintained, properly operated and properly fired, it will not only require the least possible amount of fuel, but it will also deliver the highest possible character of service. All three of these points are of direct concern to road foremen and traveling engineers. In fact, these points embody the chief part of the work of those officers, for most railroad executives now hold that the principal duties of road foreman and traveling engineers are to develop economy in the use of fuel. Economical fuel operation is a mark of good railroading. It may be possible, perhaps, to have economical fuel operation without good railroading, but no more is it considered to be good railroading unless there be economical fuel operation.

The locomotive is not a one-man machine. Its operation requires two men. One is occupied in converting water into steam, while the other is manipulating valves which permit the steam to do the work desired. The two men work at the same time. It may almost be said that the steam is being used at the same time that it is being made. There being a limit to the steam storing capacity of the locomotive, when the engineman stops using steam the fireman stops making it. At least such should be the fireman's aim. The fireman should have advance information of the approximate time of closing the throttle, so that he may control the fire accordingly. The engineer should know that the fireman has this information and see that he is guided by it.

Similar information should be common knowledge before starting trains. In this case coal should be placed on the fire a short interval before the locomotive is worked heavily. The successful engineer closely supervises the firing of the locomotive, especially at this time of the trip. The fire must be properly prepared and built up to meet the requirements.

This business of fire prepartion and fire control, like preventing the waste of coal that works out and drops off end sills of tenders, is the work of the fireman, but it is the engineer's responsibility to see that he does it. When you have an engineer who sympathetically and intelligently supervises the firing of a locomotive, you soon have a fireman who becomes more careful in his work. This, of course, is teamwork. Perfect teamwork is easy to recognize, but difficult to develop. First of all, it requires the proper state of mind in the engineer. The engineer must be made to feel his authority and responsibility in directing the work of the fireman. This assumes the full support of his immediate superiors, especially road foremen and master mechanics, and the full support of their superiors.

It is common knowledge that locomotives make trips on which several tons of coal more are consumed than on other locomotives of the same class, on similar runs, in the same service, over the same piece of track, by other crews. The difference in consumption is in the condition of the locomotive or in the work of the engineer or fireman. Habitually close supervision of the fireman makes it much easier for an engineman to suspect that an engine is getting a little "off" on steaming qualities, when he may proceed to locate the trouble and have it remedied.

There is nothing new about these considerations. Teamwork is universally desired. To realize it is the thing for accomplishment. We all acknowledge the existence of irregularities in practice. These should be removed. This paper was written to ask you to give your opinions and convictions as to how these irregularities may best be removed, after we go back to our respective railroads.

ARCH TUBES EQUIVALENT TO 1,200 LOCOMOTIVES.—Arch tubes totaling more than one million feet are in active service today. They are capable of evaporating 48,000,000 lb. of water per hour, which is equivalent to the total evaporation of 1,200 large locomotives.—*Erie Railroad Magazine.*

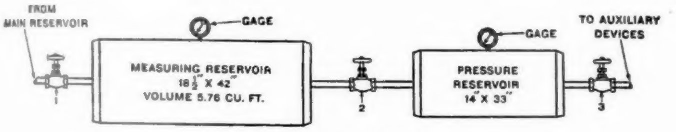
Air Brake Association Meeting

Abstracts of Committee Reports and Papers Presented at the Twenty-Sixth Annual Convention

A BRIEF account of the proceedings of the twenty-sixth annual convention of the Air Brake Association, which was held at the Hotel Sherman, Chicago, May 6 to 9, inclusive, was published in the June issue of the *Railway Mechanical Engineer,* on page 301. The following are abstracts of the more important reports and papers which did not appear in the June issue.

AIR CONSUMPTION OF LOCOMOTIVE AUXILIARY DEVICES*

The committee submitted a report of progress, giving a resumé of the work which had been done. The purpose of the committee's investigation was, (1) to investigate the rate of air consumption of auxiliary devices as found in service on locomotives; (2) to investigate the relation of air consumption by auxiliary devices to compressor operation; (3) to determine if the amount of air used is sufficient to warrant a separation of auxiliary devices from the air brake system, with a separate compressor to furnish air for them; (4) to determine if it is satisfactory to have the auxiliary devices take their air supply from the air brake system, but necessary on this account to install an additional compressor;



ALL PIPING AND FITTINGS ¾"

Fig. 1—Measuring Apparatus Used in Standing Tests of Air Operated Auxiliaries

(5) to investigate the cost of compressed air for operating the auxiliary devices used, and (6) to make recommendations with respect to the maintenance of auxiliary devices.

TESTS MADE AND RESULTS

While the data given here do not cover the subject completely, they will at least serve to give a conception as to what the use of air operated auxiliary devices on locomotives may mean in the ordinary practice of busy railroads. It is to be expected that this report will be regarded as a report of progress, and it is hoped that the work of the committee will be continued for the ensuing year.

The investigation covered in this report naturally divides itself into two parts, *viz.,* standing and running tests. The standing tests were made on locomotives in roundhouses, and consisted in measuring the amount of air used by the auxiliary devices operated while the locomotives were standing. The running tests were made on freight engines working over the road in service, and consisted of the continuous measurement of air used by the auxiliary devices in operation while the engine was running. The standing tests involved a total of 48 engines, and the running tests were made with six engines. A total of 489 individual tests were made, the results of which have been classified and arranged for the purposes of this report.

The locomotives used during these tests were not selected, nor were any locomotives inspected before the tests were made. It was desired to test the equipment just as it might happen to be available so that the data would be representative of average operating conditions. Furthermore, the standing tests were made at three division points and involved the equipment on four different divisions. The running tests were conducted on two road divisions.

Standing Tests—The standing tests involved measuring the amount of air used by the various auxiliary devices with the locomotive at rest. The form of apparatus for making this measurement is shown in Fig. 1. It consisted of two tanks connected as shown, the larger being designated as the measuring reservoir and the smaller as the pressure

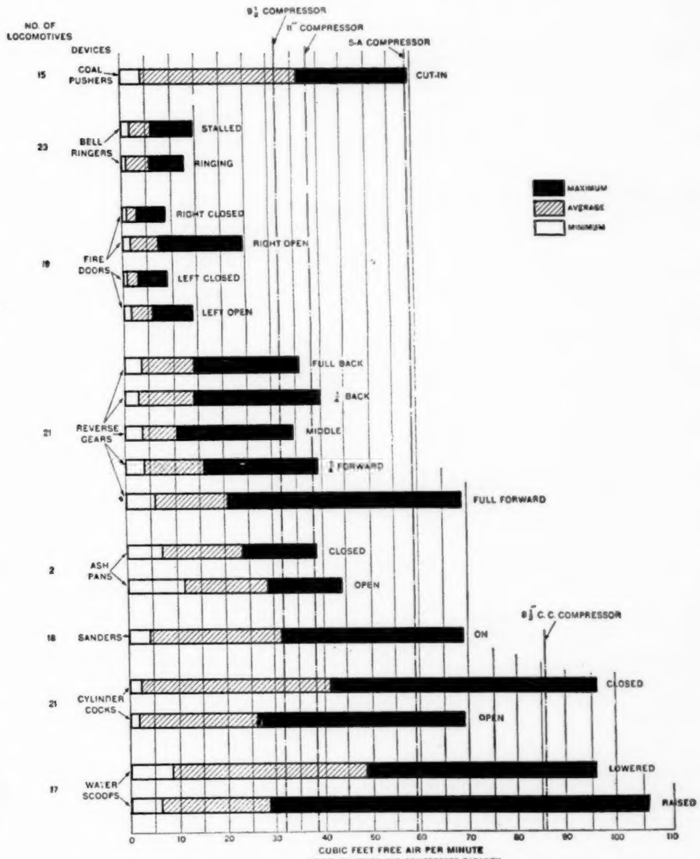


Fig. 2—Results of Standing Tests of Auxiliary Devices on All Locomotives

reservoir. The measurement of the air used by each auxiliary device was accomplished in the following manner:

The auxiliary device to be tested was disconnected from the main reservoir on the locomotive and reconnected to the measuring apparatus at globe valve No. 3. A connection was likewise made from the main reservoir on the locomotive to the measuring reservoir at globe valve No. 1. The air was measured by opening valve No. 3 and manipulating globe valves Nos. 1 and 2. The operator of valve No. 2 regulated that valve so that a constant pressure of 70 lb. was maintained in the pressure reservoir as the supply of air pressure to the auxiliary device under test. The operator of the main reservoir valve No. 1 opened this valve so as to charge the measuring reservoir up to the main reservoir pressure of the locomotive, usually 40 to 50 lb. higher than the constant pressure in the pressure reservoir. This operator

*The meaning of the term "air operated auxiliary devices on locomotives," as used in this report, can be defined as referring to all air operated devices on locomotives which are not a part of the air brake system, such as air operated fire doors, bell ringers, reverse gears, sanders, etc.

then closed valve No. 1 and noted the time required for the pressure in the measuring reservoir to drop any given amount during the time it was supplying air continuously to maintain the constant pressure in the pressure reservoir.

The air consumption was calculated as follows:

$$\frac{20 \text{ (drop in measuring reservoir)}}{14.7 \text{ (atmospheric pressure)}} = 1.36 \text{ drop in measuring}$$

reservoir expressed in atmospheres.

1.36 atmospheres $\times$ 5.76 (volume of measuring reservoir) $=$ 7.83 cu. ft. of free air supplied during the test.

$$\text{Then } \frac{7.83 \times 60 \text{ (No. of sec. in one min.)}}{78 \text{ (time of test in sec.)}} = 6.03 \text{ cu. ft.}$$

per minute.

The standing tests made on all auxiliary devices have been classified and arranged according to the type of locomotive upon which they were found, and the results are shown in graphic form in Fig. 2. Each figure on the chart shows the minimum, average and maximum rates of air consumption of all the auxiliary devices of the several types tested. The results for passenger locomotives are based on the standard passenger train reservoir pressure of 130 lb., although the actual tests were made at a constant pressure of 70 lb. In every case the data were converted from the 70 lb. basis to give the equivalent rate of air consumption at 130 lb. in the following manner:

$$\frac{\text{Rate of leakage, cu. ft. per min.}}{} \times \text{Absolute press. on locomotive (144.7 lb.)} = \text{rate of leakage on engine when main}$$

reservoir pressure is 130 lb. instead of 70 lb.; that is, the leakage is taken as proportional to the absolute pressures. The data for freight engines are based on 100 lb. main reservoir pressure, standard for freight service.

It will be noted that all charts have the capacity of air compressors indicated on them for convenient comparison with the rates of air consumption given. These values for compressor capacity are based on the rate of air delivery

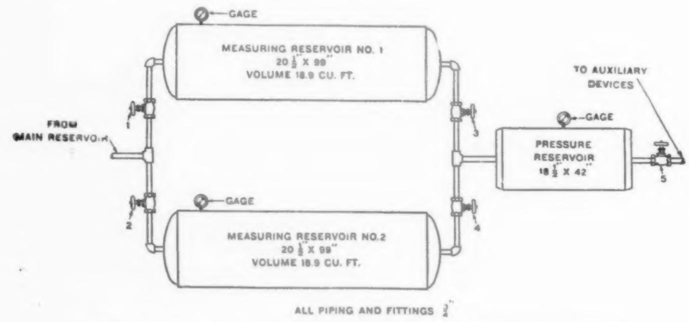


Fig. 3—Measuring Apparatus Used in Running Tests

established by the Interstate Commerce Commission's compressor condemning tests, as shown in Table I.

TABLE I—COMPRESSOR CAPACITIES BASED ON I. C. C. CONDEMNING TESTS

Type of compressor	Delivery rate, cu. ft. free air per minute, 60-lb. pressure
9½-in.	32
11 -in.	37.5
5-A	59
8½-in. C.C.	86

Running Tests—Running tests were made with the object of determining the rate and total amount of air used by the auxiliary devices while the locomotive was working in regular service. An apparatus was devised for measuring continuously the rate and amount of air used, and is shown diagrammatically in Fig. 3. This apparatus is similar to that described above and shown in Fig. 1; the only difference being that two measuring reservoirs are used, with the object of permitting the measurement of air to go on continuously.

This apparatus was manipulated so that while the air was being measured by the dropping pressure in one reservoir, the other reservoir was allowed to charge from the main reservoir in order to be ready to start measuring the supply of air to the pressure reservoir as soon as the air pressure in the first measuring reservoir was exhausted.

The measuring apparatus was installed in a caboose which was run at the head end of the train next to the engine. The piping was so arranged that with either end of the caboose toward the engine, connections could be made to the main reservoir and the auxiliary devices on the locomotive under test.

The length of running tests covered in this report varied from 3½ to 8 hours, or the time required to make a fast

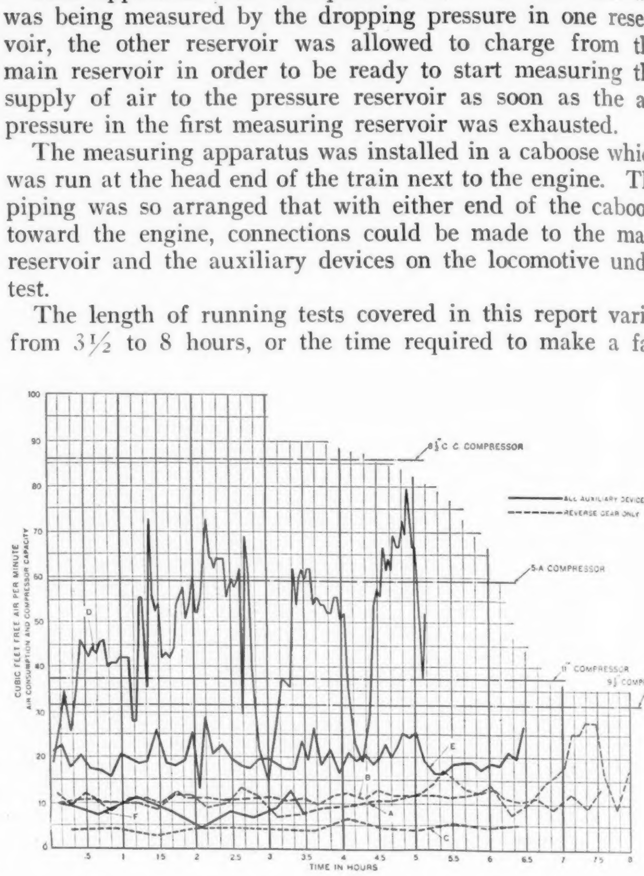


Fig. 4—Results of Freight Service Running Tests

freight movement over a division of 131 miles. The running tests made were six in number and can be divided into two classes, *viz.:* (a) Running tests in which the rate of air consumption was measured for the reverse gear only, and (b) running tests in which the rate of air consumption was measured for all auxiliary devices.

Three tests of each kind were made, and each test was made during a full trip of an engine in regular service on fast freight. The running tests are, of course, of a great deal more importance than the standing tests, in that they show the rate of air consumption as it varies during the working time of the locomotive, and it is the judgment of the committee that more tests of this kind should be made.

The tests herewith presented do not provide sufficient data for basing definite conclusions, but they do show how the leakage of auxiliary devices will vary with running conditions on the road, and that cases do exist in which the air consumption is unreasonably high, if not actually dangerous, in the sense that it increases the possibilities of an engine failure as the result of overworking the air compressor.

The running test data are shown plotted in graphic form in Fig. 4. Each of the six tests is represented by a line which shows how the rate of air consumption varied throughout the trip. The three solid lines represent tests made on all auxiliary devices, and the three dotted lines represent the tests made in which the air consumption was measured for the reverse gear only. Additional lines are shown on the charts to indicate the capacity of different air compressors in order that comparisons between the compressor air capacity and the rate of air consumption can readily be made. All of the engines used in the six tests plotted on this chart were of the same class, and were equipped with two No. 5-A air compressors and the following air operated auxiliary devices: reverse gear, double fire doors, bell ringer, sander, water scoop and cylinder cocks.

The tabulation below shows the total amount of free air used and the average rate of using during each of the six running tests shown in Fig. 4.

Locomotive designations	Auxiliary devices	Total cu. ft. free air used during trip	Cu. ft. free air used per min.
A	Rev. gear only	5,665.2	11.84
B	Rev. gear only	4,939.8	10.55
C	Rev. gear only	1,809.62	4.50
D	All devices	14,750	46.93
E	All devices	7,761.2	23.13
F	All devices	1,738.4	8.17

Cost Data—Fig. 5 has been made up from the running test data to show the relative cost of maintaining auxiliary devices at the minimum, maximum and average conditions of leakage found during these tests. The first two figures of this chart show the minimum and average rates of air consumption for the three tests in which the reverse gear only was measured and the three tests in which all auxiliary devices were measured. These values were obtained from the test data by dividing the total amount of air used during the trip by the total time of the trip in minutes. The actual values used are shown in the last column of the preceding tabulation. The remaining figures in Fig. 5 give the relative

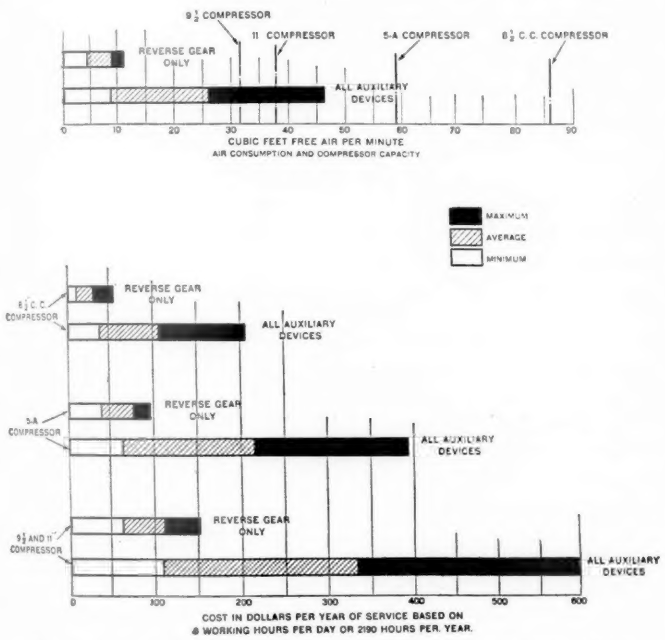


Fig. 5—Cost Data Based on Running Tests of Various Types of Air Compressors

minimum, maximum and average cost for compressed air when using various types of air compressors. There are two figures for each type of compresser, one for the tests made with reverse gears only, and the other for the tests made with all auxiliary devices. These figures show the relative cost of supplying the compressed air required under the various conditions, based on the following assumptions: (1) That the average working time for locomotives is 6 hr. per day, or 2190 hr. per year; (2) That the rate of evaporation is 7 lb. of water per pound of coal; (3) That the price of coal on the tender is $2.00 per ton, or $1.00 per 1,000 lb.; (4) That the rate of steam consumption in pounds of steam used per 100 cu. ft. of free air compressed, is in accordance with the values given in Table II. These values have been determined from a series of steam consumption tests made on each of the types of air compressors indicated.

TABLE II—STEAM CONSUMPTION OF LOCOMOTIVE AIR COMPRESSORS

Type of compressor	Lb. of steam, at 200 lb. pressure per 100 cu. ft. free air compressed: To 100 lb. main res. pressure	To 130 lb. main res. pressure
9½-in. and 11-in.	68	76.25
5A	44.7	51
8½-in. C. C.	24	25

The cost comparison figures are based upon the above assumptions only, no consideration being given to such factors as the cost of handling coal on engines, cost of water, depreciation of boiler plant and compressor plant, etc. These considerations have been omitted because the committee does not have sufficient data to accurately determine them. It is obvious that these factors would increase the costs shown, and the chart figures can therefore be regarded as the minimum conservative values.

A detailed account of the results of the tests of individual appliances was given in the report. The theoretical or computed air consumption did not account for even the minimum consumption that was found during the standing test, proving that the greatest part of the air used was wasted through leakage due to improper maintenance of the devices. The committee believes that it would be worth while to continue the test with a view to establishing more complete data upon which performance standard and condemning tests could be made.

CONCLUSIONS

(1) Auxiliary devices under average conditions were found to use too much air.

(2) Conditions frequently exist where compressor capacity may be exceeded by the demands of the auxiliary devices.

(3) Some of the data justify the conclusion that auxiliary devices should be operated separately from the air brake system. On the other hand, some of the data show that with proper maintenance this conclusion might not be warranted.

(4) Under some of the conditions shown by these data, it would not be satisfactory to connect the auxiliary devices to the air brake system and increase the compressor capacity accordingly, unless the air brake main reservoir is protected from the consequences of excessive air requirement by the auxiliary devices.

(5) Cost basis data show that better maintenance would be profitable.

(6) Standards of performance, including maximum permissible leakage, should be established upon which to condemn devices unfit for service.

(7) Means should be devised for checking and testing the performance of auxiliary devices.

RECOMMENDATIONS

The committee recommended that its work be continued and this report be regarded only as a report of progress; that the data be made more complete by investigations on individual railroads, conducted as outlined in the report, such investigations to be reported to the chairman of this committee; that steps be taken to secure better maintenance of auxiliary devices; that further experiments be made with the object of devising satisfactory means for testing, and satisfactory standards of performance which can be applied to show whether the device is fit for service; and that consideration be given to the plan of operating the auxiliary devices at a pressure lower than that carried in the air brake system main reservoir. This plan would effect a large saving in air used, but would require a separate air supply reservoir with means provided for controlling the reduced pressure.

The report was signed by C. H. Weaver (N. Y. C.), chairman; C. B. Miles (Big Four), W. W. White (M. C.), and R. E. Miller (W. A. B. Co.).

DISCUSSION

Great interest was shown in the results of the test and numerous opinions were advanced as to the cause of excessive leakage in auxiliaries and the method that should be used to overcome it. The practice of operating power reverse gears by steam when handling locomotives around the roundhouse was condemned by several speakers, who stated that steam destroyed the packing in the cylinders and caused

excessive leakage. Some roads are now equipping metal disk power reverse systems with metal packing rings. T. F. Lyons (N. Y. C.) brought out the fact that leakage in the auxiliary devices might interfere with the proper operation of the brake even though it did not result in a large waste of air. The loss due to leaks in water scoop cylinders did not cause excessive air consumption because the cylinder is operated at infrequent intervals. However, in approaching water tanks the scoop is usually dropped at the same time as the brakes are released and excessive leakage in the water-scoop cylinder might seriously interfere with the recharging of the auxiliary reservoir.

M. C. B. AIR BRAKE DEFECT CARD

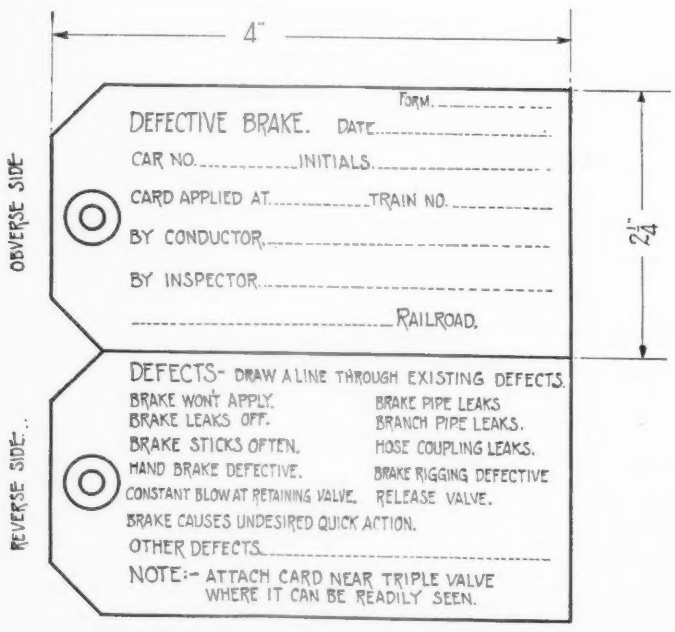
BY JAS. ELDER

General Air Brake Inspector, Chicago, Milwaukee & St. Paul

The United States Railroad Administration, Fuel Conservation Division, in Circular No. 13, of August 31, 1918, issued by Eugene McAuliffe, manager, presents 15 specific recommendations made by an Air Brake Association committee. Recommendation No. 9 is as follows: "A rule should be put into effect that trainmen must apply an M. C. B. standard air brake defect card in cases where defects develop en route or for brakes cut out by them; defect to be checked off on back of card."

The M. C. B. card shows careful thought, but the changed conditions since its last revisions demand certain alterations to meet present requirements. Some believe the brake defect card has outlived its usefulness, basing this on (a) the great difficulty in getting it applied where needed; (b) on incoming brake tests rendering it less necessary; (c) and some object because of the appearance occasional trains would present if all cars with defective brakes were carded. Assuredly the brake defect card should either be used to better advantage or discontinued.

If a defect card is yet needed and is practicable after having simplified the card, it will be very desirable to have



Suggested Revision of M. C. B. Air Brake Defect Card

mandatory instructions as to responsibility for its application. As this car is a detail of repairing, for which car men are responsible, *car men should be primarily responsible for its application;* that is, before a departing train is released from the blue signals, the inspectors should have either repaired or carded every defective brake. With this insured, it would be fair to insist that the departing train crew should card every defective brake delivered at the next terminal. However, as the incoming test should invariably be made, and as this would disclose to inspectors all defects except with cut-out brakes, it is submitted that if train men are required merely to card properly every brake brought in cut-out, all needs will be met, and the work of getting cards used by them will be lessened in a rational manner.

If one road cards all defective brakes not repaired and a connecting line does not, the former will be subjected to an unfair comparison; hence, that if real value is to be obtained from the defect card, its full and similar use must be obligatory on all roads in interchange traffic. If the defect card is to be continued the following additional means for bettering the results obtained should be adopted. The card and its use should be simplified, and then action looking toward its obligatory and uniform use by all railways in interchange service should be taken. The stub should be omitted. If it were possible to get the stubs filled out and forwarded, they would merely burden the mails and the offices. The reasons warranting omission of the stub also justify dropping from the card all matter pertaining to its use after the defect has been repaired. The size proposed is 4 in. by 2¼ in.

With all-air trains, a defect which prevents placing a certain car between other air brake cars, puts it back of the caboose. This advertises the defect on arrival at the next terminal, and as it must not go farther until repaired, there is now no use for the second card, as there was when the present M. C. B. card was designed. Where an existing defect does not require air pressure to locate it, such as one with either the hand brake or the foundation brake, it is plainly undesirable to elaborate the card by specifying the various points where such defects commonly develop. The revised card submitted is here illustrated.

DISCUSSION.

Practically all who discussed the paper agreed that the defect card gave valuable information, but that considerable difficulty was found in getting train men to use them. There was a marked difference of opinion regarding the advisability of eliminating the stubs. The association adopted a motion recommending the adoption of the air brake defect card revised as suggested in the paper, the use of this card to be confined to train men and inspectors in departure yards.

HOLDING STANDING FREIGHT TRAINS AND CARS ON GRADES

BY R. J. WATTERS

Assistant Air Brake Inspector, Northern Pacific

While many, if not most roads with steep grades have recognized the possible great dangers incident to holding standing trains and cars on grades, and have generally issued rules or instructions to guard against such dangers, yet the fact that even on such roads there is a strong tendency on the part of some officials as well as of the men in the train service to gravitate toward easier and more dangerous practices, and the further fact that many accidents from lack of the right practices occur on roads with grades too light to include them under the term mountain or steep grade roads, amply justify the Air Brake Association's careful consideration of this subject.

As before implied, probably the greater danger is due to laxness in the daily enforcement of rules and instructions on this subject. Observance of these requires more forethought and co-operation on the part of engine and trainmen to reduce the time and labor for compliance; and even then the latter will be greater than by the easier but more dangerous ways. Familiarity with steep grades, and the many deviations from safe practices that can occur so generally without an accident following, tend constantly toward habits which, unless checked regularly, will eventually result in disaster. One of the most common and dangerous of these

is failure to release and recharge the train brakes promptly after stopping on a grade, which should invariably be done whether or not the engine in control is to be cut off.

A general superintendent of a large road with several long and steep grades, expressed this matter well by the statement that it was necessary about every six months to instruct each superintendent having a steep grade, to report how well safety precautions against runaways were being observed, but not to do so until he had the trainmaster and the traveling engineer make a special investigation and report. He said that without this, a serious accident invariably occurred in time.

The following definite instructions and recommendations are submitted on the subject of this paper:

As soon as a train is stopped on a grade, brakes should be released and recharged at once. If the engine from which brakes are being operated remains attached, and keeps the train charged, as it then should, it may be held with the independent brakes; that is, by keeping the independent or the straight air brake valve in application position. An exception is where the engineer is to leave the engine. In this case enough hand brakes to alone hold the train should be applied. This should be proved by having all automatic and independent brakes off and, if the compressor may be kept running, then the independent brake should be re-applied and its brake valve handle left in application position.

If the engine from which the train brakes are being operated is to be cut off, enough hand brakes to alone hold the train, should be applied, but the trainmen should not commence to apply them until the automatic brakes are released. Where retaining valves are in use, none need be turned down, but no hand brakes should be applied until one minute after train brake release is begun.

Hand brakes used to hold cars or a train on a grade should be applied at the down-grade or lower end, thereby assuring against any car starting if uncoupled. All slack should be in, against the applied hand brakes, as well as all automatic brakes off (see previous exception about retaining valves) before cutting off an engine.

If, with the engine in control of the train cut off, another engine is to be detached, as a helper or pusher, its engineer should first cut in, release and recharge the train brakes, then release the independent brake so as to be certain the train will stand after the engine is cut off. While remaining with the train the independent brake should be kept applied on each of any such other engines.

With a descending train, the final reduction to bunch the slack, as the stop is being completed, should be followed, during the wait of one minute after release is begun before commencing to apply hand brakes (at the head end), by reversing and pushing the slack in as much more as possible, then holding the train with the independent brake while the hand brakes are being applied.

With an ascending train, see that the slack is in before cutting off by allowing it to drop back gradually, with train brakes off, until the train will stand with no aid from the engine in control. It should be held by hand brakes applied at the rear, aided by the independent brake of each other engine in the train.

If a break-in-two, or burst hose occurs on a grade, immediately apply more than enough hand brakes to alone hold the train until its brakes are again recharged. If it is a descending train, and a coupling is damaged that will take some time to repair, and if the portion of the train with the engine (ahead) can be backed so as to couple the detached hose, it should be done and the train kept recharged during any necessary wait while obtaining a repair part, as a knuckle or pin, or if a delay must ensue before putting the damaged car elsewhere, as where this occurs where the car may be switched out or to the rear end.

It should be noted that the air brakes are off before applying hand brakes on cars set out on a grade, and on level track as well, sufficient to hold them. It is not necessary to bleed the air from auxiliary reservoirs of cars so set out as long as the air brakes are off when the hand brakes are applied. In addition to the foregoing any rules regarding blocking cars should be complied with. Hand brakes applied when the car air brakes are set, may result in broken chains when the air brakes leak off, especially dangerous with one or two cars. Even where this exceptional failure does not occur, they will often be so difficult to release as to necessitate the delay and waste of air required to apply the air brakes to aid in releasing them.

HOW CAN ENGINEMEN AND TRAINMEN ASSIST IN AIR BRAKE MAINTENANCE?

BY H. A. GLICK
Air Brake Inspector, Bangor & Aroostook

While locomotive engineers are not primarily responsible for air brake design and maintenance, they can, nevertheless, aid materially by making careful and specific reports about air brake conditions on their locomotives requiring attention. Many of the defects that may arise in the course of a trip, especially leakage in the numerous pipe connections that contain air pressure, due to vibration or improperly connected pipe joints, can be discovered better by the engineer while the locomotive is under steam and air pressure and in his charge. His co-operation in reporting intelligently and reliably all brake troubles is essential to good maintenance.

Whenever trouble arises with any air brake part on an engine, the man that delivers the engine should properly book on the work report the actual defect that exists, but should not book non-essential or imaginary defects; for by so doing he causes a great deal of unnecessary work on the part of the roundhouse force. The time so used is simply wasted and might be used to good advantage performing essential work on this and other engines. Before taking an engine out the engineman should know that all air brake parts perform their functions, and not take it for granted that they do.

The trainman can assist and he should be duty bound to do so, by following the general air brake instructions now existing on all railroads, by taking greater interest in them, and consequently, in his own welfare. If he does not follow the general instructions, he should be made to do so by proper measures from his superiors, and also by the urging of his fellow workmen. He should be made to recognize the right and wrong of his part in air brake maintenance. There are times when the brake is cut out for no reason. No brake should be cut out of service unless a defect exists; then whoever cuts the brake out should specify the trouble on a a proper air brake defect card and tie the card to the cross-over pipe on the car.

Trainmen should do everything possible to stop brake pipe leakage, as this leakage causes hardship on the air compressor, takes away from the engineer the ability to properly control the amount of the application, contributes to brakes sticking and prevents the maintenance of sufficient brake pipe pressure. The practice when separating cars of closing but one angle cock, allowing the brakes on cars back of the separation to apply in emergency, should be discontinued. When separating cars, both angle cocks should always be closed and hose should always be separated by hand. When opening angle cocks on the charged portion of train, they should be opened slowly to prevent brakes from applying in emergency. When switching cars they should not be allowed to strike any harder than three miles per hour. Coupling cars at a greater speed creates shocks, which in turn are absorbed by the unions in brake pipe connections, causing brake pipe leakage. The cordial co-operation of enginemen and train-

men in the matter of air brake maintenance is very necessary in order to get the best results.

DISCUSSION

The necessity for co-operation between the trainmen and enginemen and the air brake repair men in order to promote proper maintenance, was emphasized by several speakers. One road reported good results by requiring trainmen to pass an examination on the proper handling of brakes.

THE AIR BRAKE SUPERVISOR'S RESPONSIBILITIES TO THE STORE DEPARTMENT

BY W. H. CLEGG
Air Brake Supervisor, Canadian National

The air brake supervisor's interest in this question starts with his discovery that some standard practice or regulation relative to air brake maintenance is not being adhered to, or that a locomotive or car is being held out of service awaiting the arrival of certain repair parts by reason of lack of knowledge or failure of the local officers to anticipate the requirements, and this in spite of the fact that less important stations are overstocked with the very parts that are needed to release the locomotive or car in question, or permit of adherence to standard practice covering repairs. Thus it appears that the supervisor in order to help himself must of necessity assist the stores department. The following should form the basis of the air brake supervisor's assistance to the storekeeper: (1) Providing suitable places for the care and preservation of repair parts in stock. (2) Advising as to the various repair parts and quantities required to be carried in stock at general stores. (3) Approving of sub-requisitions placed with general stores. (4) Periodical inspection of divisional stores and assistance to divisional storekeepers. (5) Preventing the accumulation of a surplus stock of repair parts that are seldom used. (6) Advising the general storekeeper where a surplus of repair parts are found so that same may be transferred to other terminals or returned to general stores.

The recommended assistance as outlined above requires but a small portion of the supervisor's time and his often unsolicited efforts will eventually be fully appreciated.

RAILROAD ADMINISTRATION NEWS

The director general has accepted from the War Department the custody of 100 locomotives which were originally constructed for the Russian government, and has arranged until further notice to continue the operation of that equipment on federally operated lines.

Prior to the present arrangements, the lines using these locomotives were obligated to the War Department for a rental based upon $45 per locomotive per day. The amount payable was considerably in excess of that required under the present agreement, which is 6 per cent per annum upon a valuation of $55,000 per locomotive, or an annual rental of $3,300 per locomotive from the date it went into service, or pro rata for any fractional part of a year. The agreement for the use of these locomotives provides that they shall be fully maintained at the expense of the director general.

COST OF TRAIN AND LOCOMOTIVE SERVICE

The total cost of train service, including locomotive service, shows a steady decrease as compared with preceding months, although increases as compared with last year, according to the monthly reports compiled by the Operating Statistics Section. For the month of April it was 112.7 cents per 1,000 gross ton miles, as compared with 119.5 in March and 126.5 in February. The cost of locomotive service per locomotive mile in April was 115.2 cents, as compared with 98.5 cents in April, 1918; 119.2 cents in March, 1919, and 120.7 cents in February. The cost of train service per train mile was 162.2 cents, as compared with 141.7 in April, 1918, 167.5 cents in March, 1919, and 169.3 cents in February, 1919. The increase in the cost of locomotive service in March this year over March last year was 17 per cent, and the increase in the cost of train service was 14.5 per cent. All items of cost show increases as compared with last year. The figures are reported by roads and by regions. The combined averages for all regions are as follows:

	April, 1919	April, 1918
Cost of locomotive service per locomotive mile	115.2	98.5
Locomotive repairs	39.4	30.6
Enginehouse expenses	9.6	6.8
Train enginemen	18.9	18.1
Locomotive fuel	43.6	40.2
Other locomotive supplies	3.7	2.8
Cost of train service per train mile	162.2	141.7
Locomotive repairs / Enginehouse expenses	55.5	43.0
Locomotive fuel	49.4	46.2
Other locomotive supplies	4.2	3.3
Train enginemen	21.4	20.8
Trainmen	25.3	23.9
Train supplies and expenses	6.4	4.5

	April, 1919	March, 1919	February, 1919
Cost of train service per 1,000 gross ton miles	112.7	119.5	126.5
Locomotive repairs / Enginehouse expenses	38.6	40.8	43.1
Locomotive fuel	34.3	37.5	40.3
Other locomotive supplies	2.9	3.1	3.4
Enginemen and trainmen	32.4	33.5	34.8
Train supplies and expenses	4.4	4.6	4.8

LOCOMOTIVE FUEL PERFORMANCE

The Fuel Conservation Section has issued a bulletin on locomotive fuel performance for January, February and March, 1919, as compared with the same period of the previous year, which shows an estimated saving in coal consumption by using less coal per 1,000 gross ton miles, or per car mile, amounting to $11,263,774. This is based on incomplete returns covering 76 per cent of the total mileage. In determining the estimated total saving for all roads in a region it has been assumed that the average per cent of saving for the whole region is the same as the average per cent for the roads in that region for which complete information is available. The grand total saving for all regions has been taken as the sum of the regional totals. In freight train service the estimated saving for all roads is $7,773,170. The saving on the roads for which information is available was 12.3 per cent. In passenger service the saving is estimated at $3,530,604, or 12½ per cent. The average cost of coal per ton shows increases in the various regions, as follows: Eastern region, from $3.48 to $3.92; Allegheny region, from $2.92 to $3.00; Pocahontas region, from $2.55 to $2.67; Southern region, from $2.82 to $3.40; Northwestern region, from $3.58 to $3.91; Central Western region, from $3.07 to $3.55; Southwestern region, from $3.13 to $4.14; Grand total, all regions, from $3.16 to $3.57.

The total tons of coal consumed in the three months amounted to 26,191,000 as compared with 30,943,000 in the corresponding period of 1918, and the total cost of coal was $93,503,000 as compared with $97,541,000. In freight service the pounds of coal per 1,000 gross ton miles averaged 220 as compared with 243.7 in the corresponding period of 1918. This is a decrease of 9.7 per cent. In passenger train service the pounds of coal per passenger train car mile averaged 20 as compared with 22½ last year, 11.1 per cent less.

DIRECTOR GENERAL APPEALS FOR EFFICIENCY AND ECONOMY

Walker D. Hines, director general of railroads, has sent the following letter to all officers and employees of railroads under federal control:

"The increased payroll cost, due to improved wages and working conditions, and the increased cost of material and supplies, are now resulting, in connection with the falling off in business, in the United States Railroad Administration incurring heavy deficits in railroad operations.

"For the first four months of this year, these deficits, after

deducting the rental due the railroad company, were about $250,000,000 or at the rate of $62,500,000 per month. This critical condition makes it imperative not only that costs shall not increase but also that every effort be made to help the government through every reasonable effort to economize and realize greater efficiency.

"These deficits, so far as they cannot be eliminated through greater economies and through increased business, will eventually have to be offset by increased transportation rates which all should endeavor to avoid.

"I ask every officer and every employee to redouble his efforts to do efficient work, to economize in the use of railroad materials, fuel and other supplies, and to use great care not to injure equipment, tools, office furniture or injure property being transported by the railroad and for which payment must be made if injury occurs, and further than this, to try to encourage others to do the same. Please remember that if you should fail in any of these respects to do what you reasonably could and ought to do you would impose unnecessary cost upon the government. This is true because it is the government which has to bear the loss if there is one or which will receive the profit if any is earned.

"Do not wait for the other fellow to begin this improvement, but begin yourself. Do not decline to help because some other fellow is not helping; turn in and help, and keep on setting the other fellow a good example. You are interested in the great movement for the improvement of the condition of the individual worker. You can aid in that great movement, through efficiency and saving in reducing the cost of railroad operation, because thereby you help to keep down transportation rates, and thereby you help to keep down the cost of living. An increase in rates will give occasion for an increase in prices of what the public consumes and that will mean a new cycle of increasing still further the cost of living. It is to the interest of every man, woman and child in this country that this shall be avoided just as far as possible.

"The government, during federal operation of the railroads, as a result of its nation-wide control, has been able to do much to promote justice to railroad employees through making proper increases in their wages and proper improvement in their working conditions. In the nature of things the result cannot be equally satisfactory to all, involving 2,000,000 employees, because it is not possible in this vast undertaking to satisfy equally every one or even every class of these employees. If any employee feels he has a ground for such dissatisfaction he ought to remember the remarkable strides that have been taken by the government in the last 12 months in the recognition of the just rights of railroad employees, and compare the situation today with what it was in December, 1917, before federal control began. It has been a source of satisfaction to me to aid in this great work. Will you not, in turn, do justice to the government and help sustain my work, as director general, and also justify what has been done for you, by doing all that you can reasonably do to save the government money and to increase the efficiency of your work?

"I sincerely want your assistance in demonstrating that the railroads may be operated successfully even though the wages of its employees have been materially increased."

ORDERS OF REGIONAL DIRECTORS

Cars Rented to War Department.—The regional director, Eastern Region, by circular 500-51A773 promulgates an order from the Division of Operation to the effect that where freight cars are furnished for the War Department, the rental rate is to be uniformly $3 a day, beginning with June 1.

Rental Charges on Equipment.—Order 207 of the Southwestern regional director cancels Orders 183 and 185 previously issued by the Southwestern regional director pertaining to rental charges on locomotives and other equipment and outlines new rates for locomotives, dining cars, locomotive cranes, etc., effective March 1. These rates do not abrogate those named in any contracts of prior execution.

U. S. R. A. Standard Cars; Repairs.—The regional director, Eastern Region, by circular 500-101A771 promulgates a notice from the Division of Purchases that when it becomes necessary to make repairs on standard freight cars, or standard locomotives, orders for material, before being placed, should be referred to the director of the division, H. B. Spencer, Washington, so that any surplus material accumulating at the car plants can be properly distributed.

Safety Appliances on Freight Cars; Time Limit September 1.—The regional director of the Eastern region, by Circular 500-92A767, calls the attention of federal managers to the laws of Congress, the orders of the Interstate Commerce Commission and the rules of the Master Car Builders' Association, designed to insure the complete equipment of all freight cars with the legal safety appliances by September 1, 1919. Foreign as well as owned cars should be equipped under certain regulations.

Flexible Staybolts.—Northwestern Regional Purchasing Committee Bulletin 146 states that the American Locomotive Company has completed the installation of equipment necessary for the manufacture of flexible staybolts and will prepare to furnish them upon order.

New Locomotives Moved Free.—The regional director, Eastern Region, by circular 500-1-106-A783, advises that no freight charges are to be assessed on any class of new locomotives moving from the works of the builders to the purchasing roads, whether under their own steam or dead.

Locomotive Fuel Contracts.—Supplement 17 to Northwestern Regional Purchasing Committee Circular 3 contains the following clause which will be incorporated in all contracts for locomotive fuel: "In the event the railroad is released from federal control before the expiration of this contract, it is understood that the corporate owners have the option to be exercised at their pleasure, of being substituted for the director general of railroads, as to the benefits and obligations of this contract, effective upon the date the owners assume control." This will not require the approval of the corporate companies at this time.

Superheaters.—A. T. Hardin, regional director, Eastern Region, by circular 500-1-97A728A promulgates for the information of federal managers the order of the director of the Division of Capital Expenditures relative to the application of superheaters to locomotives. The order says: "Consideration by the Mechanical Section of the Division of Operation develops that these superheaters will not pay for the cost of application, irrespective of the cost of the material, if the engine is not actually in service by October 1, 1919. It is of course expected that business judgment will be exercised in installing the superheater even after that date, but unless the corporations are willing to stand the operating charge as well as the capital charge for applying superheaters after October 1, 1919, the program should cease as of that date."

Capital Expenditures less than $1,000.—A. T. Hardin, regional director, Eastern Region, by circular 2700-A776, quotes a letter from Washington calling attention to apparent violations of the spirit of the rule which allows federal managers to make expenditures, chargeable to capital, without first consulting the corporation, provided the total expenditure is less than $1,000. Corporations have made protests that many items coming within the limit are really parts of a general program, and do not properly stand by themselves. Among such items are:

(1) Office facilities—typewriters, tabulating machines, desks, etc., spread over eight or ten months. (2) Machine tools evidently part of a general improvement of shop facilies but split up into single purchases. (3) Expenditures incident to heavier rail, divided up into monthly charges, giving no indication of the scope of the program. (4) Fencing,

divided up into short sections * * * (5) Tie plates and rail anchors, divided up into short sections. (6) Rebuilding freight cars reported under the heading of the individual car number. Federal managers are advised to refer such matters, where possible, to the corporate officer, to avoid these objections.

REDUCING EXHAUST NOZZLES TO OVERCOME FRONT END AIR LEAKS*

BY F. P. ROESCH
Supervisor, Fuel Conservation Section, Northwestern Region

The manager of the Fuel Conservation Section, United States Railroad Administration, under date of August 1, 1918, sent out Fuel Conservation Circular No. 8, addressed to all motive power officials concerned with locomotive maintenance. The circular called particular attention to the prevalence of air leaks around the outside steam pipes on superheated steam locomotives at the point where these pipes enter the smoke arch, and advised how these leaks could be detected by means of an ordinary torch test.

While in some instances the recommendations embodied in circular No. 8 were fully complied with, in other cases it was found that proper measures were not used.

The usual methods pursued in taking care of the air leaks around these steam pipes was to pack the opening between the pipe and gland with fibrous asbestos packing, either rope asbestos or plaster being used. Tests have proved that through the action of the exhaust this packing is gradually pulled into the front end, eventually leaving a combined opening around the two steam pipes in the average construction, equal to an orifice 8½ in. in diameter.

These air leaks, of course, do not occur suddenly, consequently the effect on the draft is gradual, and this in turn gradually reduces the steaming qualities of the locomotive. It is because locomotives gradually fail for steam that nozzle bushing is eventually resorted to, as did the steam failures occur suddenly the cause would be investigated and corrected.

In order to determine the exact effect of reducing nozzles and disarranging front end apparatus to overcome the effects of these leaks and to improve the gradually failing steaming qualities of the locomotive, the Fuel Conservation Section authorized a series of tests to be conducted to see what the losses amounted to in increased fuel consumption.

In conducting these tests no particular locomotive was selected, the locomotive test being one in regular chain gang freight service and assumed by all concerned to be in good condition. Draft gages were used in front and behind the diaphragm, in the firebox and in the ash pan. In addition to the draft readings, pyrometer readings were also taken at stated intervals as well as cylinder indicator cards at various speeds and cut off. A dynamometer car was employed in order to register the draw bar pull under varying conditions so that the results obtained would not be based on the tonnage alone, but equated on the train resistance. The tender was cut off, drained and weighed prior to taking coal on each trip. Only the coal consumed in actually pulling the train was taken into consideration, all coal used on sidings and at other stops being used from a separate source.

The locomotive tested was of the light Mikado type and superheated, having cylinders 26 by 30 inches, 63-inch driving wheels, 200 pounds steam pressure, with a calculated tractive effort of 54,720 lb. The tests were conducted over a double track freight division, 91 miles long, having a maximum grade of .67 per cent, the same engine crew being used throughout all tests.

The first trip was made with the locomotive as found. On the completion of this trip, the openings around the steam pipes were packed with rope asbestos, and it was found that the average draft in the front end was raised two inches, as shown by the draft gauge. As this now gave a vacuum in the front end greater than necessary to produce the desired vacuum in the firebox, it was decided to open the nozzle a sufficient amount to reduce this.

On the first trip it was found that the draft gauge in front of the diaphragm registered practically double the height of the column of water as registered by the draft gauge behind the diaphragm, indicating that the draft plate was so adjusted as to offer quite an obstruction to the flow of gases from the firebox to the atmosphere. It was, therefore, decided to raise this plate in order to better equalize the draft.

On the next trip the openings around the steam pipes were again packed with asbestos and front end cement, as inspection on arrival showed that the greater part of the packing applied on the previous trip had pulled out. The nozzle was enlarged ⅛ inch in diameter and the draft plate raised as noted in the preceding paragraph. On this trip the locomotive showed a marked decrease in the consumption of coal per 1,000 G. T. M. equated on the draw bar pull as registered by the dynamometer car. It also showed a decrease in cylinder back pressure at the same speed and cut off, due, of course, to the enlarging of the nozzle.

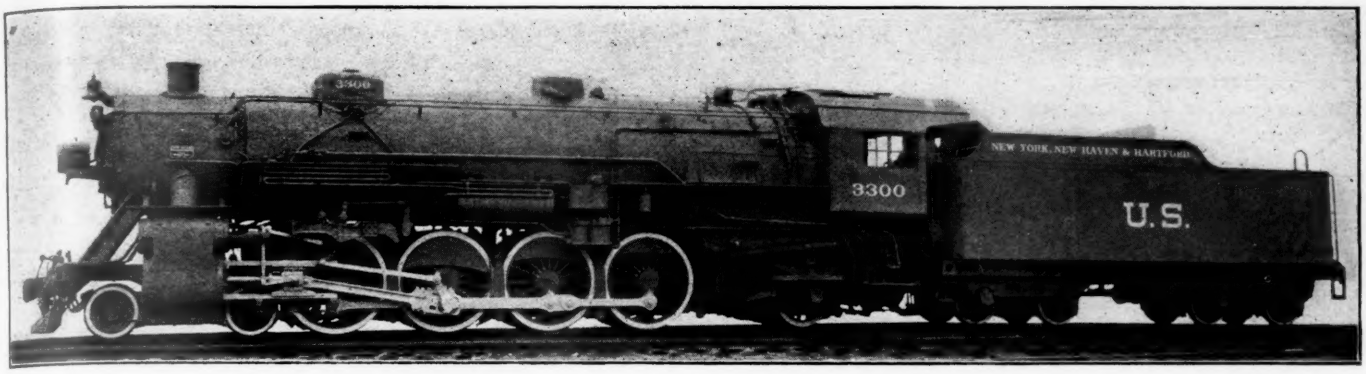
As the front end vacuum was still greater than necessary, it was decided to further increase the diameter of the nozzle on the following trip.

On the next trip the nozzle was enlarged ⅛ inch more in diameter, or a total of ¼ inch above the size originally carried. The draft sheet was left as adjusted on the previous trip. Finding, however, that the packing around the steam pipes had again partially pulled out, it was decided to seal these openings by means of plates made of No. 10 gauge steel, slightly corrugated, the outer circumference of these plates being welded to the smoke arch on the inside of the arch and the inner circumference of the plates welded to the steam pipes. An electric welder was used, thereby permanently sealing these openings. On this trip, while the locomotive did not show any decrease in fuel consumption per 1,000 G. T. M. over the previous trip, it did show an increase in locomotive efficiency, due to the further increase in the size of the exhaust nozzle, and as a point had now been reached where the fuel consumption and locomotive efficiency practically balanced, and it having been decided that any further increase in the size of the exhaust nozzle would affect the steaming of the locomotive to such an extent as to increase the coal consumption, the tests were concluded.

The final results can be briefly summarized in the following statement: Opening the nozzle ¼ inch or 4.5 per cent of the diameter, giving an increase of 9.3 per cent in area, resulted in a decrease in fuel consumption of 14.3 to 21.17 per cent, the comparisons as shown for the different trips wherein the larger nozzle was used being 14.3, 17.2, 18.2 and 21.17 per cent, the difference being due to variations in the quality of coal, weather conditions, etc. The efficiency of the locomotive was increased from 8.1 to 16.5 per cent based on the averages at various speeds and cut off, as shown by indicator cards and dynamometer records. The locomotive steamed equally as well with the larger nozzle as with the one originally used. The raising of the diaphragm resulted in a better distribution of the draft over the fire, and decreased the fuel consumption about 3 per cent.

On the whole, the tests brought out forcibly the necessity of maintaining nozzles with the largest possible diameter consistent with good steaming; of maintaining air tight front ends in order that the large nozzle can be successfully used, and of so adjusting the draft plate as to maintain an even distribution of draft over the entire grate surface, as well as to carry it at such a height as to provide ample area for the free flow of gases from the firebox to the stack.

*Abstract of a paper read at the convention of the International Railway Fuel Association, held at Chicago, May 19-22, 1919.

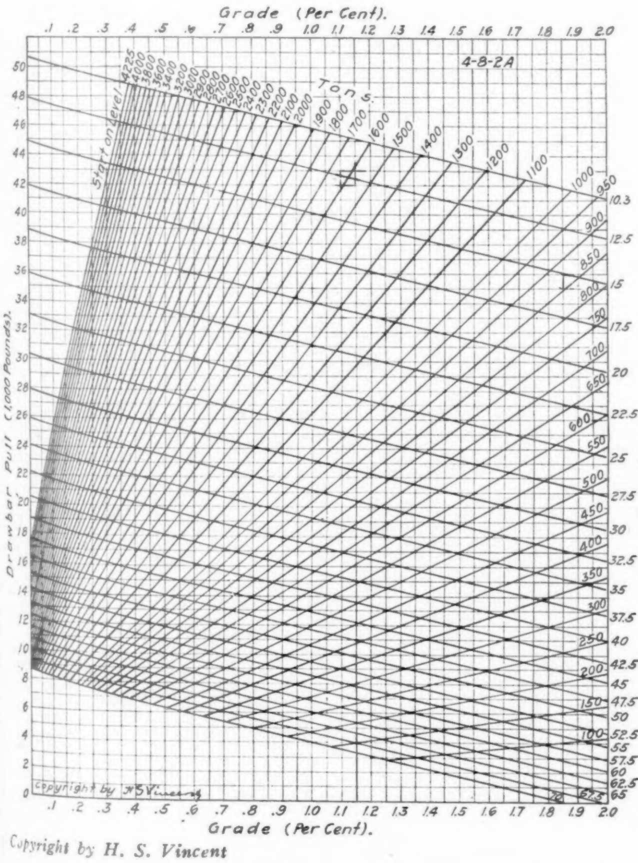


The U. S. R. A. Standard Light Mountain Type Locomotive

Standard Light Mountain Type

Last of the Administration Designs to be Built; Total Weight 327,000 lb.; Tractive Effort 53,900 lb.

THE first of the Railroad Administration standard light Mountain type locomotives has recently been turned out at the Richmond works of the American Locomotive Company and assigned for service on the New York, New Haven & Hartford. This is the last of the standard designs prepared by the Railroad Administration from which



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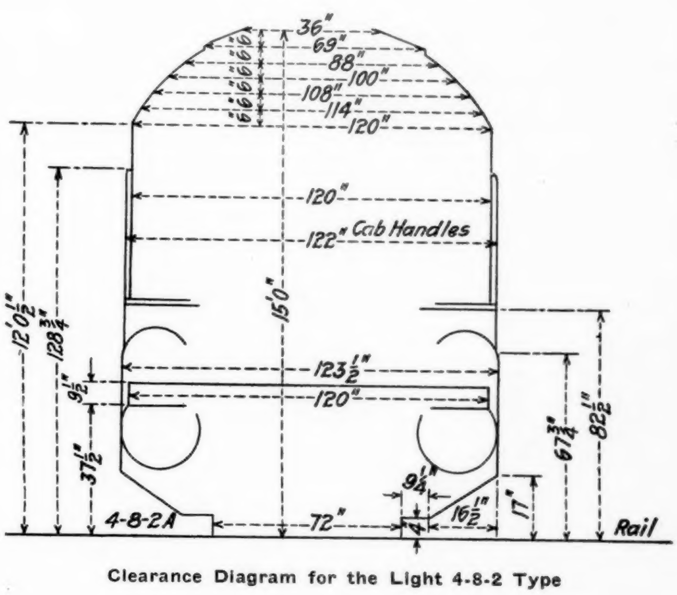
Standard Light Mountain Type Tonnage Rating Chart

locomotives have been built and locomotives of each of the twelve standards are, therefore, now in service.

These locomotives were designed on the basis of rail loads of 55,000 lb. on each driving axle. The actual weight in working order is 327,000 lb., of which 224,500 lb. is on the drivers. The engines produce a tractive effort of 53,900 lb., with a factor of adhesion of 4.2. In the table is presented a comparison of some of the more important dimensions and ratios of the standard light Mountain type with other moderate size locomotives of this type designed to meet conditions which would not permit of the use of maximum axle loads. With the exception of the Canadian Pacific locomotive few Mountain type locomotives designed for passenger service have been built with piston strokes greater than 28 in.

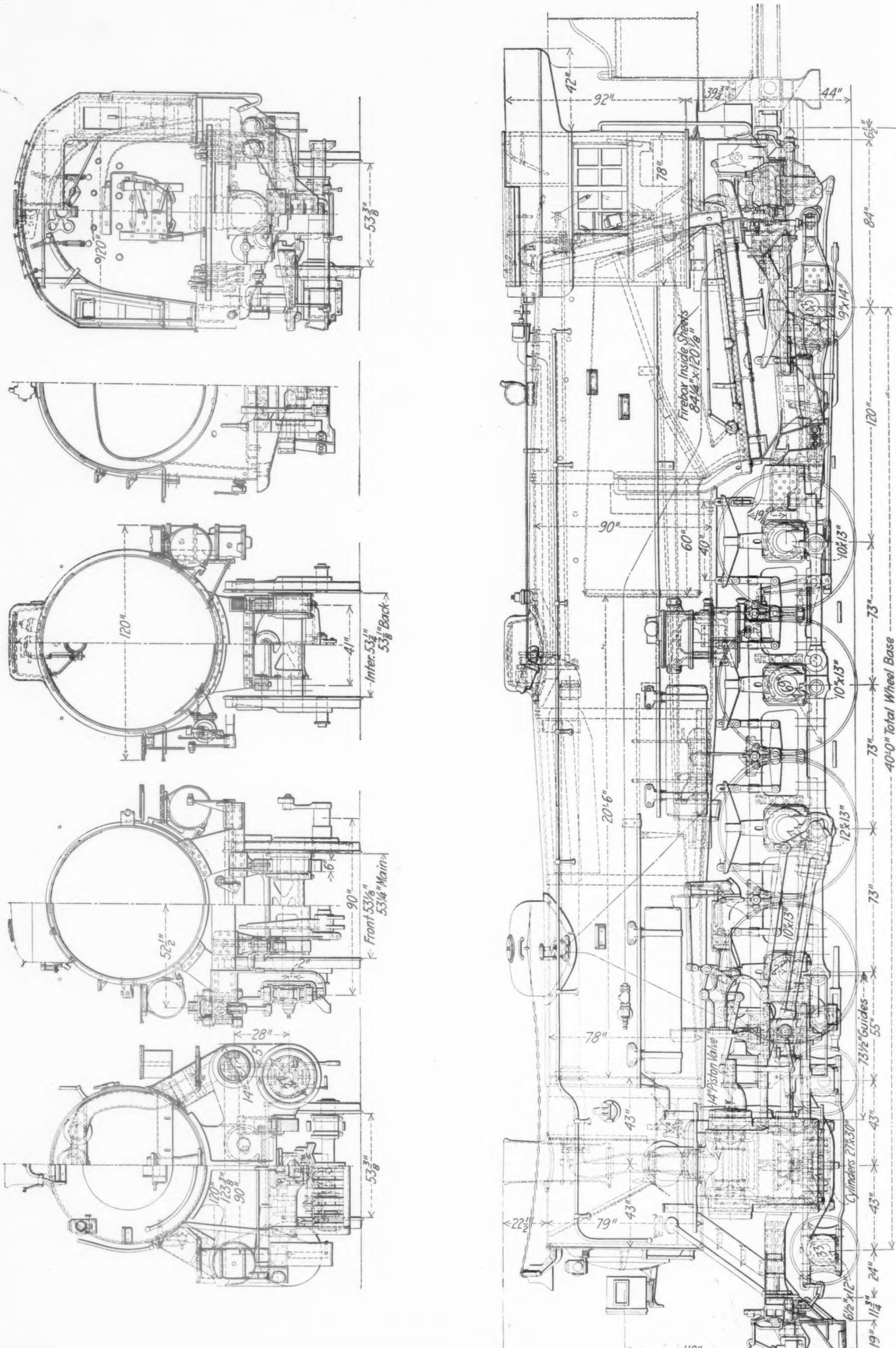


Clearance Diagram for the Light 4-8-2 Type

COMPARISON OF THE PRINCIPAL DIMENSIONS OF LIGHT MOUNTAIN TYPE LOCOMOTIVES

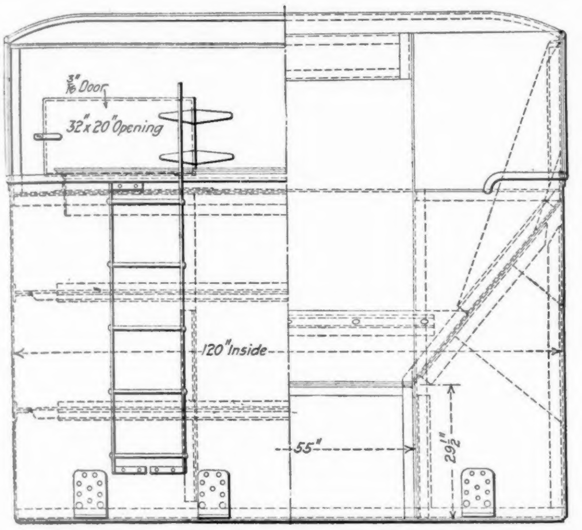
Road	U.S.R.A.	Cent. of Ga.	C.R.I. & P.	Can. Pac.
Year built	1919	1919	1913	1915
Tractive effort, lb.	53,900	47,800	50,000	42,900
Total weight, lb.	327,000	316,000	333,000	286,000
Weight on drivers, lb.	224,500	209,500	224,000	192,000
Diameter of drivers, in.	69	69	69	70
Cylinders, dia. and stroke, in.	27 x 30	27 x 28	28 x 28	23.5 x 32
Boiler pressure, lb.	200	190	185	200
Heating surface, total, sq. ft.	4,121	3,649	4,117	3,667
Superheating surface, sq. ft.	966	961	944	760
Grate area, sq. ft.	70.3	66.8	62.7	59.6
Tractive effort × dia. drivers ÷ equivalent heating surface	667.7	648.0	623.5	625.0
Equivalent heating surface ÷ grate area	79.2	76.2	88.2	80.7
Firebox heating surface ÷ equivalent heating surface	6.2	5.8	3.4	5.5

It will be seen that the light Mountain type has cylinders of 30 in. stroke, which is also the case with the standard heavy



Elevation and Sections of the Standard Light 4-8-2 Type Locomotive

Mountain type locomotive. Except for its greater tractive effort, partly due to the increased cylinder stroke and partly to the greater boiler pressure, the standard light Mountain type compares closely with the Chicago, Rock Island & Pacific Mountain type built in 1913. The heating surfaces compare closely, although the standard locomotive has a considerably larger grate than the earlier built locomotive.



Half End Elevations of the Standard 10,000-Gal. Tender Tank

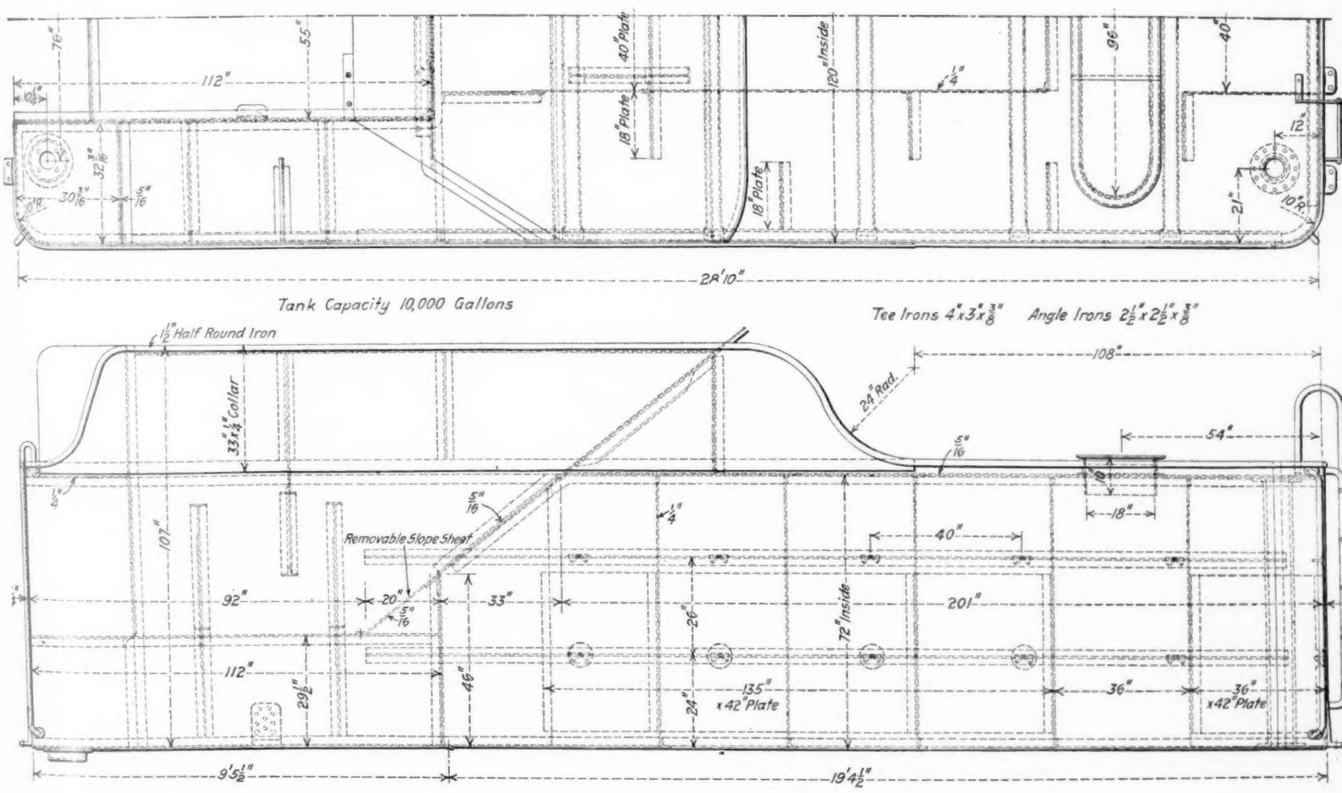
In design the light Mountain type locomotive is essentially the same as the other standard types, following closely the lines of the heavy Mountain and the two Pacific types.

The boiler is of the conical wagon top type, with the dome set on the third course. The firebox includes a combustion chamber extending forward 60 in. from the throat sheet, leaving for the tubes a length of 20 ft. 6 in. There are 216, 2¼-in. tubes and 40, 5½-in. flues for the elements of the type *A* superheater. The same number of tubes and flues are also used in the boiler of the heavy Pacific type locomotive, the length of which, however, is 19 ft., with a 38-in. combustion chamber. The size of firebox at the mudring is the same for both boilers. The boiler of the light Mountain type is fitted with a Shoemaker power operated firedoor.

The frames are similar in design to those of other single unit standard types. The width is six inches and the top rail has a maximum depth of 7⅛ in. over the pedestals, with a minimum of six inches between the pedestals. The lower rail has maximum and minimum depths of 4¾ in. and 4¼ in., respectively. The cylinders are carried on a single front rail of slab section, cast integral with the main frame. This rail tapers under the cylinder fit from a depth of 10⅝ in. at the rear to a depth of 9⅝ in. at the front, the width being 6 in. under the cylinders and to a point 30 in. back from the front end of the casting. Unit steel cradle castings are spliced to the rear of the main frames, the joint being of the same type used on all of the other designs which are fitted with trailer frames.

The cylinders, pistons and valves are similar in details to those on practically all of the other locomotives, the valves being of the piston type and 14 in. in diameter. The front and back cylinder heads are interchangeable between this locomotive and others having cylinders 27 in. in diameter, including the heavy Mikado, the light Santa Fe and the heavy Pacific types. The cylinder and valve chamber bushings, valve bull rings and packing rings, piston bull ring and packing rings and crosshead shoes are all of Hunt-Spiller gun iron.

The main and side rods differ in no essential from those on any of the other locomotives. The side rods are of slab section, this being the rule the only exceptions to which are in the case of the two Pacific type locomotives, which have I-section side rods. There is a considerable degree of interchangeability in the side and main rod bearings between the various classes of standard locomotives. The back end main

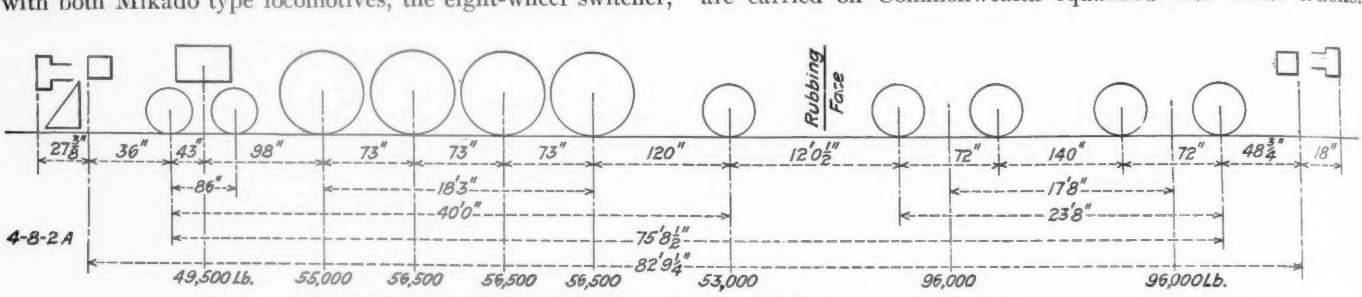


The Railroad Administration Standard 10,000-Gal. Tender Tank

Elevation and Sections of the Standard Light 4-8-2 Type Locomotive

rod brasses of the light Mountain type interchange with those of the heavy Mikado, light Santa Fe and heavy Pacific types, while the front end main rod brasses interchange with both Mikado type locomotives, the eight-wheel switcher, Mikado, heavy Pacific and light Santa Fe types are interchangeable.

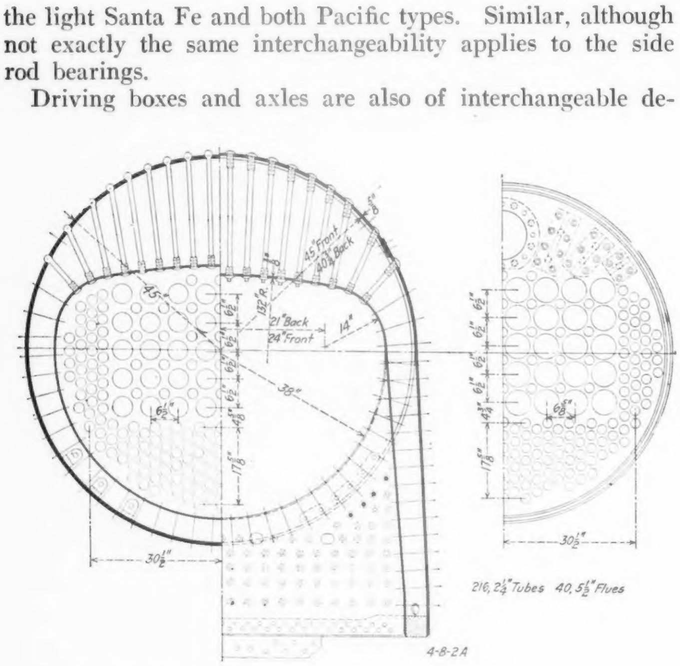
The tenders have Commonwealth unit frame castings and are carried on Commonwealth equalized four-wheel trucks.



The Distribution of Wheel Loads for the Standard Light Mountain Type

the light Santa Fe and both Pacific types. Similar, although not exactly the same interchangeability applies to the side rod bearings.

Driving boxes and axles are also of interchangeable design to a very considerable degree. The journal sizes on the front, intermediate and back pairs of drivers of the light Mountain type are 10 in. in diameter by 13 in. in length. With the exception of the main journals, those of the light Pacific, both Mikado types and both Santa Fe types have the same size and both axles and driving boxes interchange. The main journals of the light and heavy Mountain, heavy



Half Sections and Tube Sheet Layout of the Light Mountain Type Boiler

The tank has a capacity of 10,000 gallons, carries 16 tons of coal and is fitted with the Locomotive Stoker Company's coal pusher. The tanks are built up of ¼-in. and 5/16-in. plate with 2½-in. by 2½-in. by ⅜-in. angles at the corners, for the attachment of the splash plates and for the crossties. Two T-irons of 4-in. by 3-in. by ⅜-in. section are used as horizontal stiffeners on each side of the water space and to these the ends of the crossties are attached. The cistern opening has a length of 96 in. across the tank and a width of 18 in.

The clearance diagram and wheel loading diagrams which are included were prepared by F. P. Pfahler, chief mechanical engineer of the Division of Operation, of the Railroad Administration. Actual weights are shown on the wheel loading diagram. The tonnage rating diagram was prepared and is copyrighted by H. S. Vincent. The curves of hauling capacity are constructed for a car resistance of four pounds per ton. The chart may be used for any other car resistance or for any combination of resistances by converting them into terms of grade.

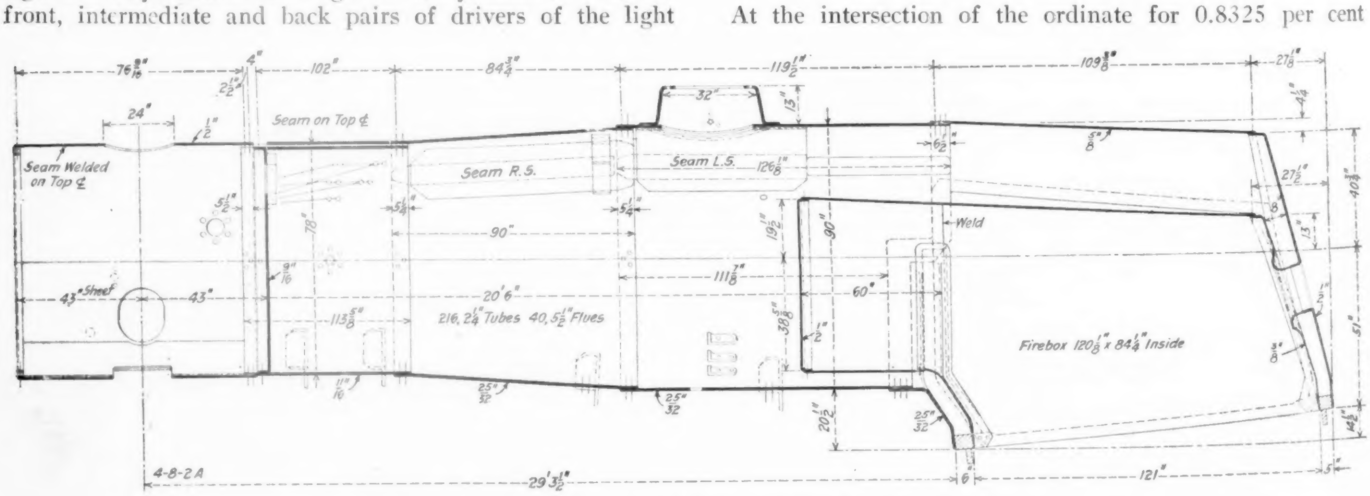
1 lb. car resistance = .05 per cent grade
1 deg. curve uncompensated = .04 per cent grade

For example, find the tonnage which can be hauled in passenger service on 0.5 per cent grade combined with a five degree uncompensated curve at 40 m. p. h. The resistance of passenger coaches at 40 m. p. h. is 6.65 lb. per ton.* The equivalent grade is then:

$$0.5 + (5 \times .04) + (2.65 \times .05) = 0.8325 \text{ per cent.}$$

At the intersection of the ordinate for 0.8325 per cent grade with the drawbar pull curve for 40 m. p. h., we find 800 tons as the capacity of the locomotive.

A list of the specialties on all of the standard locomotives



Boiler for the Standard Light Mountain Type Locomotive

*See the *Railway Mechanical Engineer* for November, 1918, page 607, for a table of passenger cars resistances for use with these charts.

was published in the March issue of the *Railway Mechanical Engineer,* p. 137. The principal dimensions and data for the light Mountain type locomotive are as follows:

General Data

Gage	4 ft. 8½ in.
Service	Passenger
Fuel	Bit. coal
Tractive effort	53,900 lb.
Weight in working order	327,000 lb.
Weight on drivers	224,500 lb.
Weight on leading truck	49,500 lb.
Weight on trailing truck	53,000 lb.
Weight of engine and tender in working order	519,000 lb.
Wheel base, driving	18 ft. 3 in.
Wheel base, total	40 ft. 0 in.
Wheel base, engine and tender	75 ft. 8½ in.

Ratios

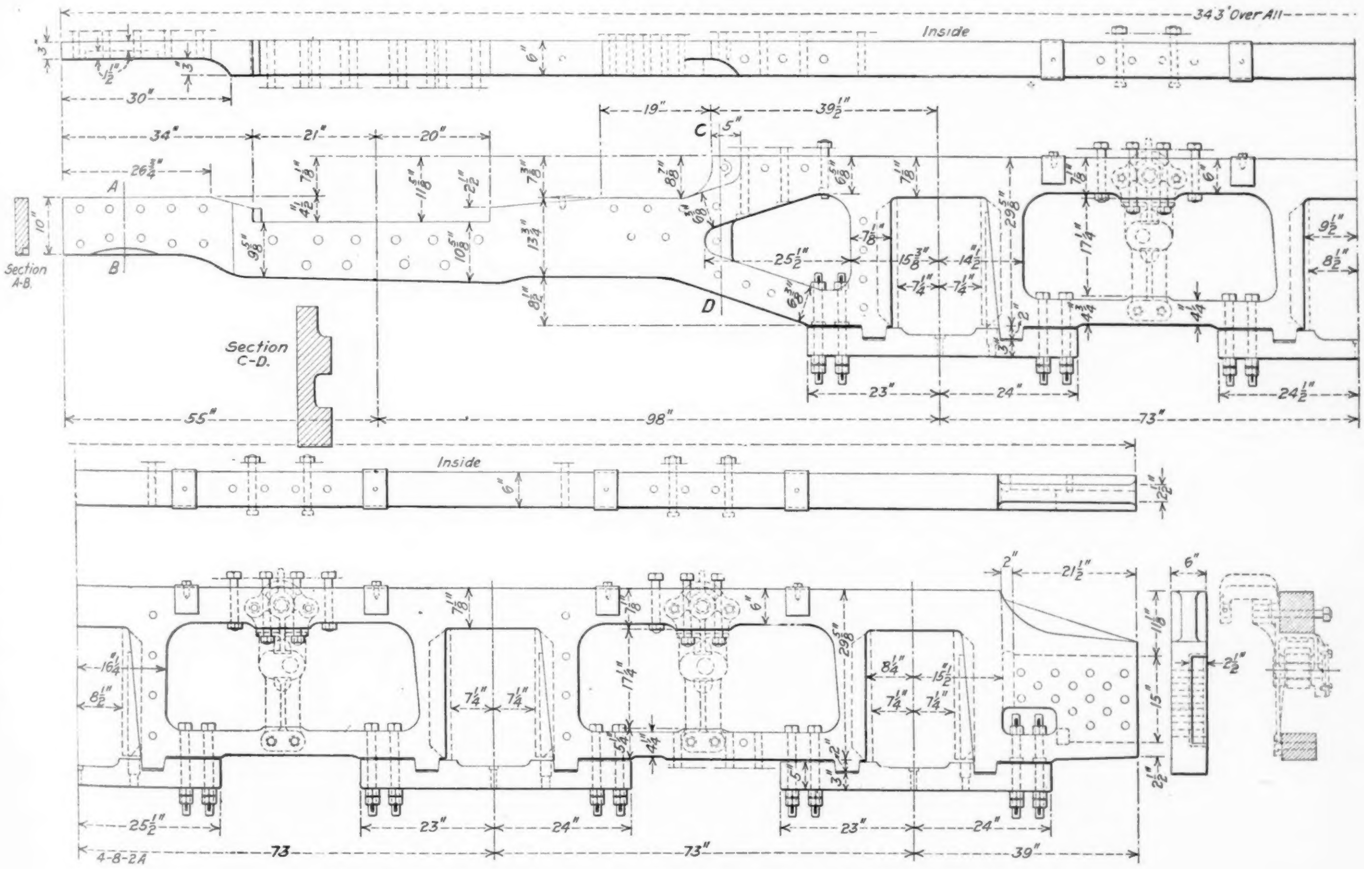
Weight on drivers ÷ tractive effort	4.2
Total weight ÷ tractive effort	6.1
Tractive effort × diam. drivers ÷ equivalent heating surface*	667.7
Equivalent heating surface* ÷ grate area	79.2
Firebox heating surface ÷ equivalent heating surface,* per cent	6.2
Weight on drivers ÷ equivalent heating surface*	40.3
Total weight ÷ equivalent heating surface*	58.7
Volume both cylinders	19.9 cu. ft.
Equivalent heating surface* ÷ vol. cylinders	279.9
Grate area ÷ vol. cylinders	3.5

Cylinders

Kind	Simple
Diameter and stroke	27 in. by 30 in.

Valves

Kind	Piston
Diameter	14 in.
Greatest travel	7 in.
Steam	1¼ in.
Exhaust clearance	⅛ in.
Lead	¼ in.



The Frame of the U. S. R. A. Standard Light 4-6-2 Type Locomotive

Wheels

Driving diameter over tires	69 in.
Driving journals, main, diameter and length	12 in. by 13 in.
Driving journals, others, diameter and length	10 in. by 13 in.
Engine truck wheels, diameter	33 in.
Engine truck, journals	6½ in. by 12 in.
Trailing truck wheels, diameter	43 in.
Trailing truck, journals	9 in. by 14 in.

Boiler

Style	Con. wag. top
Working pressure	200 lb. per sq. in.
Outside diameter of first ring	78 in.
Tubes, number and outside diameter	216—2¼ in.
Firebox, length and width	120⅛ in. by 84¼ in.
Firebox plates, thickness	Tube and throat, ½ in.; others, ⅜ in.
Firebox, water space	Front, 6 in.; others, 5 in.
Flues, number and outside diameter	40—5½ in.
Tubes and flues, length	20 ft. 6 in.
Heating surface, tubes	2,597 sq. ft.
Heating surface, flues	1,176 sq. ft.
Heating surface, firebox, including arch tubes	348 sq. ft.
Heating surface, total	4,121 sq. ft.
Superheater heating surface	966 sq. ft.
Equivalent heating surface*	5,570 sq. ft.
Grate area	703 sq. ft.

Tender

Tank	Water bottom
Frame	Cast steel
Weight	192,000 lb.
Wheels, diameter	33 in.
Journals, diameter and length	6 in. by 11 in.
Water capacity	10,000 gal.
Coal capacity	16 tons

*Equivalent heating surface = total exaporative heating surface + 1.5 times the superheating surface.

STORAGE OF COAL BY RAILROADS DURING 1918*

BY H. H. STOEK

Professor of Mining Engineering, University of Illinois

About two years ago the writer sent out a questionnaire to several hundred parties storing coal in quantities varying from a few tons stored in the ordinary house-cellar to hundreds of thousands of tons as stored on the docks along the Great Lakes and by some of the large industrial concerns. The replies to this questionnaire were studied and a tentative set of conclusions drawn up, and sent to the parties who had answered the original questionnarie, with the request that they be thoroughly criticized. As a result of these criticisms, a revised set of conclusions was drawn up and published in Circular 6 of the Engineering Experiment Station of the University of Illinois.

Realizing that during the period of the war the conditions under which coal was stored were unusual, because of the pooling of coal and because the coal furnished was dirtier

*Abstract of a paper presented at the convention of the International Railway Fuel Association at Chicago, May 19-22, 1919.

and less carefully sized than under normal conditions, another questionnaire was sent out during the fall of 1918 to practically the same list of persons as the previous one, asking for the experiences of those who had stored coal during the year 1918 and for a criticism of the conclusions published in Circular 6. A similar questionnaire was sent to a large number of power plants in the state of Illinois, and a large number of fires in coal piles were studied during the summer and fall of 1918. In these several studies, railroad storage was only one of the problems included and furthermore, the study had particular reference to Illinois and Middle West coals.

On March 11 a conference was held in Chicago, at which the general subject of railroad storage was discussed and the general conclusions in Circular 6 were endorsed. Each one was asked to furnish the writer his own conclusions upon railroad storage and copies of all instructions issued by railroads in his territory to be studied and summarized by a sub-committee consisting of Messrs. McAuliffe, Roesch, Collett, Hardy and the writer, at a meeting held in Urbana, March 25. At that meeting certain general conclusions were drawn up as representing what in the opinion of the committee represents safe practice at the present time and these preliminary conclusions were issued by Mr. McAuliffe in a circular addressed to the railroads of the country as a guide to them in storing coal during 1919.

Why Should Railroads Store Coal?—The insurance feature of coal storage is so self-evident as not to need discussion, and the equalization of equipment throughout the year has been fully discussed in the reports of the several coal storage committees. (See also Railway Administration circular.)

Coal stored in summer costs less to transport than would the same amount hauled during the winter. By relieving the roads of transportation cost, general traffic is helped.

Other reasons for storing coal by the producer or by the consumer need not be considered here, as the railroad is a transporting agent only.

The railroads are also interested in the storage of coal, because they are the largest users of it, using more than 25 per cent of the total output for their own uses, and since the transportation of the coal output forms about 34 per cent of the freight carried by the railroads of the United States, the railroads should, therefore, not only protect their own interests by storing coal, but should encourage both the mine operators and consumers to store coal so as to help stabilize the coal industry in order that it can be conducted more nearly up to its full time efficiency and thus decrease the present excessive but absolutely necessary overhead charge due to the fact that the miners of the country work only about 200 days per year.

Suggestions Regarding Storage of Coal by Railroads.—The replies to the questionnaire sent out in 1918 asking for experiences in storing coal during 1918 and for a criticism of the conclusions published in Circular 6, show that the experience of the past year has confirmed these conclusions* in very great part.

Summarizing these suggestions:

Each railroad should study its own storage problem in great detail. Get ready to store before it is time to begin actual storing by outlining a definite policy far enough in advance so that every one who will have to do with the storing can receive *definite* instructions, not merely suggestions. Then when storing begins, see that the instructions are carried out to the letter. Many failures have been due not to faulty instructions from the head office but to the fact that they have not been followed.

*The conclusions included detailed instructions regarding the storage of coal as regards location of piles, season when coal should be stored, kinds and sizes which may safely be stored, methods of piling, ventilation and precautions to be taken to avoid spontaneous combustion.

When it is time to store, prepare a place carefully. Do not wait until the coal to be stored is on the track and then dump it anywhere to get it out of the cars. Specify the kind of coal that is to be stored and see that the specifications are carried out by having an inspector at each storage pile who is competent, not only to inspect the coal furnished and reject it if not according to specifications, but who has authority to see that the storage instructions are carried out to the letter.

Prepare definite instructions as to the sizes of piles for different coals and for the different kinds of storage appliances that may be available.

Watch the stored coal carefully for any evidence of heating and if the temperature rises sufficiently, begin to move it in time. See that adequate machinery for handling the coal is available and always in condition to be used. Do not store coal unless you are prepared to do it properly and to watch it thoroughly after it has been stored.

Attention to these details will very largely prevent heating of coal or if heating occurs will prevent loss from fires.

It should be understood that each coal storage is a distinct proposition and while it is believed that the suggestions in this paper will be helpful to any one wishing to store coal, they are suggestions and guides only. They are not absolute facts and subsequent experience may show changes to be advisable.

Effect of Storage Upon the Properties of Coal.—The heating value of coal as expressed in B. t. u. has been shown by experiments of the United States Bureau of Mines and by Professor S. W. Parr of the University of Illinois, to be very little decreased by storage. It must be admitted, however, that the opinion is very wide-spread that storage coal burns less freely than fresh coal. This opinion is by no means universal amongst railroad men, for it is distinctly stated by some that the storage coal burns better than the fresh coal.

Experiments at the University of Illinois have indicated that coal that has been in storage can be burned as readily as fresh coal if a thinner bed is kept on the grate and the draft properly regulated. This, of course, applies particularly to stationary plants.

Insurance Adjustments.—An attempt has been made to obtain information regarding the adjustment of insurance in connection with the storage of coal but very incomplete information had been received at the time of writing. It is suggested that this subject is worthy of much more careful and extended study, possibly by a subcommittee of the Fuel Association.

STORAGE SYSTEMS

Choice of a Storage System.—In the choice of a storage system, the following points should be considered:

(1) The location, size, and topography of the available storage ground.

(2) The capacity of the desired installation, that is, the amount of coal which it is desired to load and unload in a given time.

(3) The cost of the plant.

(4) The cost of maintenance.

(5) The cost of operation.

(6) The amount of breakage to be permitted in handling the coal.

(7) The way in which the coal is received, in open or box cars, or in boats.

(8) The length of time the coal must be kept in storage.

(9) Climate: A dry climate with cold nights such as is found in Colorado, for instance, may give different conditions than will be found in Illinois, where there is a great deal of moisture in the air and the summer nights are almost as hot as the days.

The requirements of an ideal plant are:

(1) Adequate ground area, so that different kinds of coal may be stored separately if necessary.

(2) Adequate facilities for rapidly and economically transferring coal from cars or from boats into the storage piles.

(3) Adequate facilities for rapidly and economically reclaiming the coal and for rapidly moving any part of the pile which shows evidences of taking fire.

(4) Adequate track facilities, with gravity facilities, if possible, for handling cars.

(5) Means for preventing undue breakage in handling.

(6) Adequate available water supply.

(7) Low cost of installation, maintenance, and operation per ton of capacity. A storage plant is in operation very irregularly and costs are likely to be correspondingly higher because of the heavy fixed charges.

(The paper gave detailed analyses of the advantages and disadvantages of methods of storage particularly applicable to railroad conditions. Replies to questionnaires summarizing current practice and opinion were also included.)

Limit Of Wear For Steel Wheels

Tests Show Flanges of Wheels Worn Below the Present Condemning Limit Have Adequate Strength

A TEST was recently conducted by the testing department of one of the large railroads to determine by comparison with worn cast iron wheels whether or not rolled steel wheels, worn 1/4 in. below the present scrap wearing limit, can be used with safety. To make this test

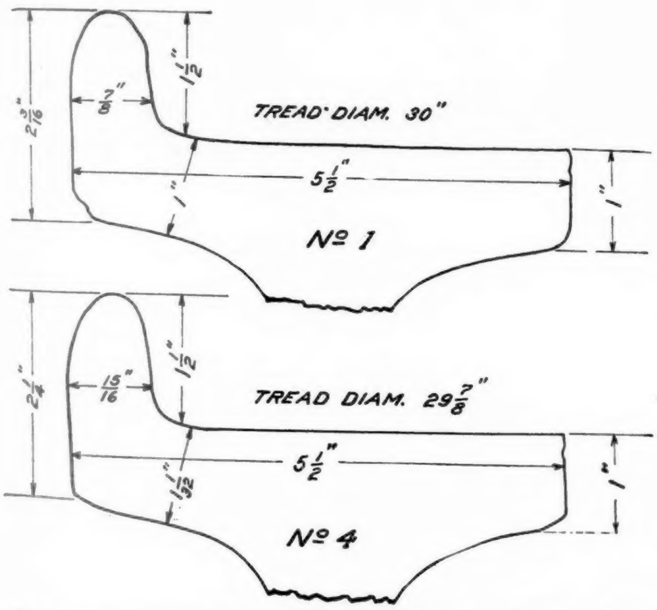


Fig 1—Cross Section and Contour of Wheels to Present Scrap Wearing Limit

four rolled steel wheels were selected from a lot of scrap wheels. The wheels had been in service under locomotive tenders and had treads worn from 2 3/8 in. to 2 1/2 in. below the new diameter, about 1/4 in. above the limit marks. They were rolled in 1917 from three different heats.

The treads of wheels numbered 1 and 4 were turned to a thickness of 1 in. or to the present scrap wearing limit. All flanges were turned to the minimum allowable thickness of 15/16 in. and with vertical surfaces and sharp fillets similar to the worn condition developed in service. Cross sections of the treads and flanges are shown in Fig. 1 and Fig. 2.

In order to make a comparison with worn cast iron wheels, three wheels were selected for test from among the scrap wheels at a large wheel foundry. These wheels were cast at three different foundries the weight and dimensions being as follows:

Wheel number	44 997	2,328	158,891
Date cast	May 27-16	Sept. 16-07	Aug. 14-14
Stenciled weight	740 lb.	700 lb.	625 lb.
Flange thickness	13/16 in.	1 in.	1 in.
Tread diameter	32 13/16 in.	32 3/4 in.	32 11/16 in.

Drop Tests

The M. C. B. drop test machine at the wheel foundry was used for the tests. The wheels were supported in a way that caused the entire thrust to be taken by the flange. The three steel blocks on which the flange rested were rounded off so as to eliminate any cutting action against the flange, and to confine the supported area to the vertical surface above the fillet. These blocks were supported on three 5-in. anvil blocks, which are the standard equipment of the machine. An iron band surrounding the wheel and blocks

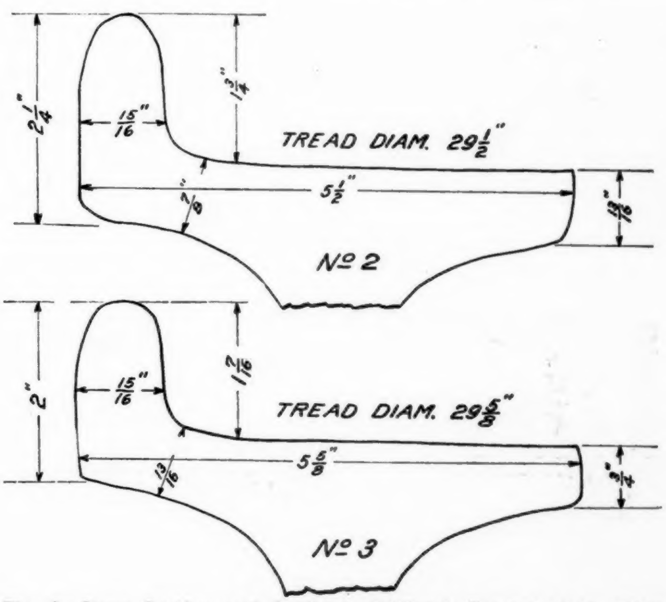


Fig. 2—Cross Section and Contour of Wheels Turned 1/4-In. Below Present Scrap Wearing Limit

was used to prevent the blocks moving out of place. The tup weighs 200 lb. and has a flat, round face, 8 in. in diameter.

The results of the drop tests are shown in the following table:

Wheel No.	Kind	Tread thickness, in.	Flange thickness, in.	Blows from 6 ft.	Blows from 9 ft.	Blows from 12 ft.	Blows from 20 ft.
1	Steel	1	15/16	5	0	10	5*
2	Steel	3/4	15/16	12	2	10	15
3	Steel	3/4	15/16	5	0	10	30
4	Steel	1	15/16	5	0	10	9†
44,997	Cast iron	..	13/16	..	..	1†	..
2,328	Cast iron	..	1	3†	..	..	..
158,891	Cast iron	..	1	1†	..	..	..

*Plate cracked after two blows. Flange not broken.
†Flange broken off.

Typical fractures developed under the drop test are shown in Fig. 3 and Fig. 4. None of the fractures showed any

imperfections or irregularities in the metal structure. Wheel No. 1 developed only a slight elongation of the crack through the plate after it had received three additional blows from a height of 20 ft.

STATIC TESTS OF ONE INCH SECTIONS

Sections one inch thick were cut from each of the steel wheels and tested in a Riehle testing machine in a manner which is shown, with the plate removed, in Fig. 5. This arrangement provides a loading, which produces a thrust

Fig. 3—Failure of Steel Wheel No. 4

in a direction parallel to the axis of the wheel similar to that which occurs in service. A clearance was cut in the lower end of the ram, causing the load to be applied the same distance from the tread in each case.

The results of these tests are as follows: Specimens from wheels numbered 1 and 4, whose treads had been turned to the present scrap wearing limit, broke under loads of 40,450 lb. and 34,720 lb. respectively. Specimens from wheels numbered 2 and 3, whose treads were turned 1/4 in. below the present scrap wearing limit, broke under loads of 22,540

Fig. 4—Failure of Cast Iron Wheel No. 2328

lb. and 24,900 lb. respectively. The character of the failures are shown in Fig. 6.

CONCLUSIONS

The results showed a decided superiority of steel over cast iron wheels under the drop test. Of the three cast iron wheels tested, the best showing was made by the one which had the flange broken off after three blows of a 200-lb. tup from a height of 6 ft., whereas the only steel wheel whose flange was broken, failed after nine blows from 20 ft. Fifteen and thirty blows from 20 ft. caused no failure of the two steel wheels which were turned below the present limit.

These results indicate that a reduction of the thickness of the tread does not affect the strength of the flange in rolled steel wheels.

The failures of the 1-in. sections were similar, in that all broke in the same way at about the same place. In no case did the break occur at the throat of the flange or at the

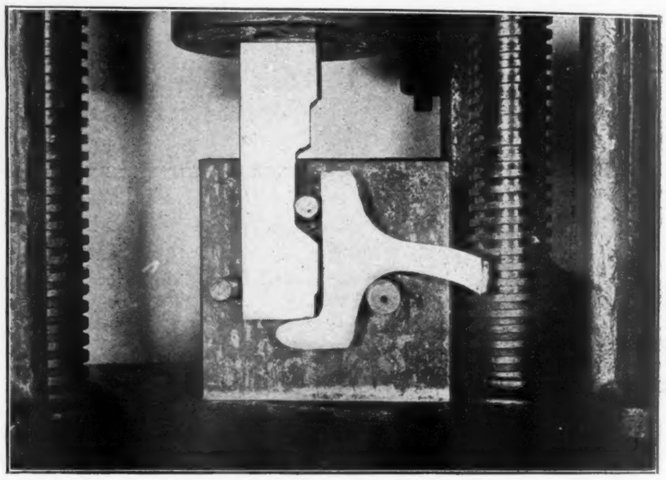


Fig. 5—Manner of Applying Load in Test of 1-in. Sections

thinnest section of the tread, but to one side of the thinnest section, toward the center of the tread.

The results of the drop tests indicate that the rolled steel wheels with treads turned 1/4 in. below the present scrap wearing limit and flanges of the minimum allowable thick-

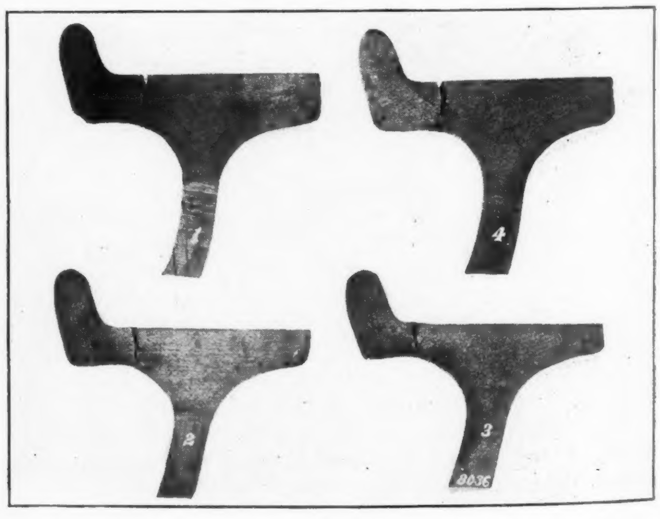


Fig. 6—Failures of 1-in. Sections Taken From Steel Wheels.

ness, have decidedly stronger flanges than cast iron wheels the flanges of which are worn to the minimum allowable thickness.

The nature and similarity of the failures of the 1-in. sections indicate that there is no weakening effect on the flange proper, caused by reducing the tread thickness. There is, however, a weakening of the tread due to its own reduced section.

Master Boiler Makers' Convention

Reports and Discussion; Brick Arches, Ash Pans, Threading of Radial Stays, and Other Subjects

A PARTIAL report of the proceedings of the convention of the Master Boiler Makers' Association, held in Chicago May 26 to 29, was given in the June issue of the *Railway Mechanical Engineer,* which also contained a list of the newly elected officers of the association. In addition to the addresses and papers given in the June issue, other reports of committees were offered to the convention and discussed by the members.

APPLICATION OF BRICK ARCHES

The minimum distance between the grates and the lower part of the arch at the throat sheet for different classes of locomotves depends upon the local conditions; that is, the grade of coal being used, whether it fills up badly or not; and whether the firemen have been taught to shake grates and keep the fire worked down. There are a great many engines which have eight inches as a minimum distance between the grates and the lower part of the arch, and the railroads are getting along very successfully with it.

The proper distance from the door sheet to the top of the brick arch and from the crown sheet to the top of the brick arch for various classes of locomotives is also a local condition. Arches have been run in a great many cases as close to the crown sheet at 11 in. with good results, but some railroads insist that the arch shall not be closer than 16 to 18 in. The distance from the door sheet to the top of the arch is a distance varying greatly, depending upon the length of the firebox. The arch should be run as long as possible in all cases and the top of the arch should be up higher than the top of the door.

The report was signed by L. M. Stewart (A. C. L.), chairman.

An individual report on this subject was submitted by E. W. Young, general boiler inspector, C. M. & St. P., an abstract of which is given below.

It is impossible to set any figure for the minimum distance between grates and the lower part of arch tubes for different classes of locomotives, as so many variables must be taken into account. The distance from the grates to the lower part of the arch tube may be less with a throat sheet that sets back at an angle from the vertical than for a throat sheet which is vertical. It may be less where the grate is flat, than where there is a steep pitch of the front end of the grate, or it may be less in a short firebox than in a long firebox.

The distance from the grates to the lower part of the arch tube may be less in a compound locomotive with its mild draft than in a simple locomotive with its sharp draft. It may be less with one grade of coal than with some other grade.

On account of the variable conditions, it is impossible to set any figure. A good rule and a simple one may be stated as follows: Locate the arch tubes as high above the grates as the design of the firebox will permit. In some cases the arch tubes have had to be located as near as 8 in. to the grate, and yet satisfactory results have been accomplished; however, better results will be obtained if the throat sheet be such that the distance of 18 in. can be obtained between the grates and the arch tubes. The proper distance from the door sheet to the brick arch in various classes of locomotives is just as difficult to determine as it is to answer the first question. One answer might be stated as follows: The brick arch should approach the door sheet as near as possible without restricting the area between the arch and the door sheet, to a figure below the gas area through the flues. It is very seldom, however, that we find a case where the arch can be run as close to the door sheet as the above rule would dictate, due to the fact that under such a condition the gas area between the arch and the crown sheet is unduly restricted. It might be stated that an arch may be built back to within 24 in. of the door sheet, provided conditions other than the relation of the arch to the door sheet will permit.

A good rule in connection with arch designs is that an arch should be as long as conditions will permit, and it is usually the case that these conditions must be studied from two or three angles before we can decide just what the length of the arch shall be, or what the distance shall be between the arch and the door sheet. It would be very much easier to get an ideal arch if the arch were first designed and then the firebox built around it. If the latter condition existed, it would be very easy to answer the two questions, and they would read about as follows: The grates should be placed 18 in. below the front end of the arch tubes. The door sheet should be placed about 24 in. from the back end of the arch. It should be understood, however, that the above two specifications can rarely be made use of for the very reason that arches are built into fireboxes instead of fireboxes built around arches.

Arch tubes must be so located in the flue sheet that there will be access to the front end of the arch tube through the waterleg. In order to get this access through the waterleg, and through a plug hole in the outside throat sheet, arch tube locations are often found to be impracticably low and in such instances a special spacer block is used to elevate the front course of arch brick, so that practical firing clearance is obtained.

The distances discussed above as found on the different types of locomotives used on the Chicago, Milwaukee & St. Paul, and also on the United States Standard locomotives, are shown in the following table:

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY

Type	Distance between grates and lower part of arch tube, inches	Distance from door sheet to brick arch, inches
1-5	13½	45½
G-4	18	37
A-1	16	49
A-2 Straight top	13½	53½
A-2 Slope top	14	44½
B-4 Wide firebox	14½	64½
B-4 Narrow firebox	11½	67
G-6	13	46
K-1	24	59
L-2	23½	49
U. S. STANDARD LOCOMOTIVES		
0- 6-0	10	28
0- 8-0	10	37
4- 6-2-A	13	53
4- 6-2-B	15	47
2- 6-2-A	13½	52
2- 8-2-B	15	47
4- 8-2-A	15	46
4- 8-2-B	15	42
2-10-2-A	14½	42
2-10-2-B	15	59

The use of syphons in the place of arch tubes will, in very many cases, permit of considerably better firing clearance than can be obtained where arch tubes are used. There may be many cases of firebox construction, in which an arch on syphons will be practical, while arches on arch tubes would be impracticable. Syphons make a good foundation for a brick arch, and on account of being so substantial they make a practical device to take the place of arch tubes.

DISCUSSION

The discussion developed the fact that there was considerable difference of opinion regarding the proper location

of the arch. The point was brought out, however, that it is largely governed by local conditions. It is considered necessary to have the area between the arch and the crown or door sheet from 10 to 25 per cent greater than the area through the tubes.

DESIGN OF ASH PAN AND DRAFT APPLIANCES

Your committee has failed to discover a recognized rule for designing ash pans. The result of our investigations indicates that methods are largely the result of experiments which have developed designs which seem best suited to the type of locomotive and condition of service. The objective to be attained was a self-cleaning arrangement of sufficient storage capacity to prevent the necessity of dumping the ashes except at regular ash pan cleaning points; and to prevent the cinders from burning and warping the pan. The lower parts are designed to be practically air tight, air for draft being admitted at the upper parts only. Ash pan air inlets of eight classes of locomotives averaged 14 per cent of the grate area which, from information obtainable, seems to be about the average air opening in ash pans for coal burning engines.

With the modern wide firebox, pans are made wide at the top, projecting several inches beyond the mud ring with vertical sides to prevent sparks from falling or being blown out by side winds. These upper plates are sloped toward the hopper or storage part so that cinders will slide to the hopper. There seems to be a tendency to sacrifice this slope to obtain greater draft opening, which has resulted in some instances in the cinders piling up on the wings and shutting off the draft, as well as causing stuck grates and burned grates and connecting bars. Therefore the slope from the hopper to the edge of the pan should be not less than 30 degrees and rather than lose this slope, it is better policy, if possible, to get increased opening from back or front.

When locomotives are being designed, the ash pan should be considered and provided for as an important part of the machine, and not as something to be hung on after the locomotive has been set up. The modern ash pan is expensive to construct and still more expensive to maintain, and the greatest possibility of improvement seems to be in the designers who may find it practicable to change the frame lines or other parts sufficiently to give relief where it is greatly needed.

MAINTENANCE OF ASH PAN

Slides, hoppers and dumps should be maintained in an operative condition. Grates should be maintained in first-class condition. Broken, burned or warped grates should not be allowed in service. One bad grate often causes damage to a whole section and also causes waste of fuel and damage to the ash pan.

No air openings should be allowed in the ash pans except those provided for in the design. This is particularly important in the case of oil burning locomotive draft pans, for the reason that air leaks permitted at other points than those designed usually result in brick work troubles as well as interfering with the proper steaming of the locomotive.

Air leaks at the lower parts of coal burning locomotive ash pans are extremely undesirable and annoying, not only on account of burning and warping the plates of the ash pan, but particularly on account of sparks dropping and causing fires along the right of way. It is a mooted point whether fires set from locomotives are not more frequently from the pans rather than from the stack.

FRONT END DRAFT APPLIANCES

The method of determining the design of front end draft appliances has, no doubt, as its basic principle, what was known as the Master Mechanics' front end, and like other parts, constant experiments and experience develop a type of front or setting to suit the conditions.

All parts of ash pan and front end appliances should be carefully fitted and securely bolted in place so that there is no reasonable probability of any part becoming displaced, and should be maintained at all times in first-class condition, each part performing its full function strictly in accordance with the design, particularly draft openings and passages which govern the flow of air and gases through the firebox flues and smoke arch. Dampers which are designed to be operated should be maintained in an operative condition and air admitted only at such points as the drawings provide for. Draft passages should be maintained so that all the draft will pass through those channels, which is not the case if loose or poor fitting plates are allowed. Draft appliances, which include deflecting plates, nozzle, petticoat pipe and stack, may be designed and adjusted to thoroughly clean cinders from front ends, and because plates were not well fitted, leaks direct to the stack may be sufficient to defeat the object of the design, causing cinders to accumulate in the front end, sometimes resulting in burning and warping front end rings and doors and overheating the lower joints of exhaust and steam pipes and developing leaks at those parts.

FRONT END LEAKS

The committee is of the opinion that positively no air leaks should be permitted and that where front ends show indications of burning on account of the combustion of cinders, it is just as often the result of poor fitting plates and air leaks as it is of faulty design or of wrong adjustment of draft appliances. We also incline to the opinion that we should make use of the autogenous welding process to secure permanently to the smoke arch and flue sheet a suitable sheet iron border to which to bolt deflecting plates. This border may be spot welded when being applied or welded in solid. At any rate, it can be an absolutely tight fit, in fact, air tight, if desired. An arrangement of this kind will expedite the work of applying or removing deflecting plates and simplify front end inspection. Petticoat pipes should be maintained to practically a true circle free from holes or indentations, and be securely held in central position between nozzle and stack.

As an item of interest to this association, and to give an idea of the general dimensions of draft openings, the following is given. We find in eight different classes of coal burning locomotives the following comparative dimensions of draft passages:

Eight Coal Burning Locomotives.—Ash pan air inlets equal 14 per cent of grate area, or 39.5 per cent of grate opening, and is 4 per cent more than flue opening area. From this it would appear that pan opening and flue opening are practically the same, while stack area is about 10 per cent of flue opening area.

Seven Oil Burning Locomotives.—These have the same stack opening, flue opening and grate area. They have no grates, but the air inlets through the fire or brick pan, also called the draft pan, are 28 per cent less than the flue opening area, and are 69 per cent, or a little more than twice the stack opening. The comparatively small air openings to the fire in oil burning engines compared to coal may raise the question of whether or not we are allowing too much air to the coal burner, especially with a clean fire. We are of the opinion that the size and location of these openings have been worked out principally by experimental process and, while perfection may not have been attained, when we observe a good steaming oil burner at work one is pretty apt to conclude that there is not much room for improvement.

The effect of proper upkeep of ash pan and front end appliances is to save fuel and maintaining a high standard of condition of those parts saves labor, and effects an economy. Like many other economies not reducible to plain figures, we must accept the above statement because we know that

well maintained draft appliances and ash pans do fully perform their functions of furnishing the necessary drafts for economical combustion of the fuel and prevent fires being set out and the destruction and loss of property, which is an important economical consideration. Well fitted and well secured parts of the draft appliances reduce the liability of displacement and failure on account of not steaming and loss of fuel due to poor steaming, and also reduce the necessity of constant changing of front end draft appliances, which is another considerable economy. Finally, well maintained draft applainces may well be considered the difference between a satisfactory, efficient locomotive, which everyone appreciates, and a poor steaming inefficient machine that no engineer wants to run.

The report was signed by Geo. Austin (A. T. & S. F.), chairman; E. J. Nicholson (C. & N. W.), F. Beyer (Penn. Lines), H. F. Weldin (Penn..) and H. B. Nelson (Mo. Pac.)

DISCUSSION

Methods of eliminating the leaks around the steam pipe holes in the front ends were discussed at length. The best results were said to be secured by welding a plate around the opening.

One member told of results which had been secured by the use of cast steel ashpans. He submitted an estimate of cost showing the expense of applying and maintaining sheet steel pans for 15 years to be $915, while the corresponding cost of cast steel pans was $214.

BRACING LOCOMOTIVE TENDERS

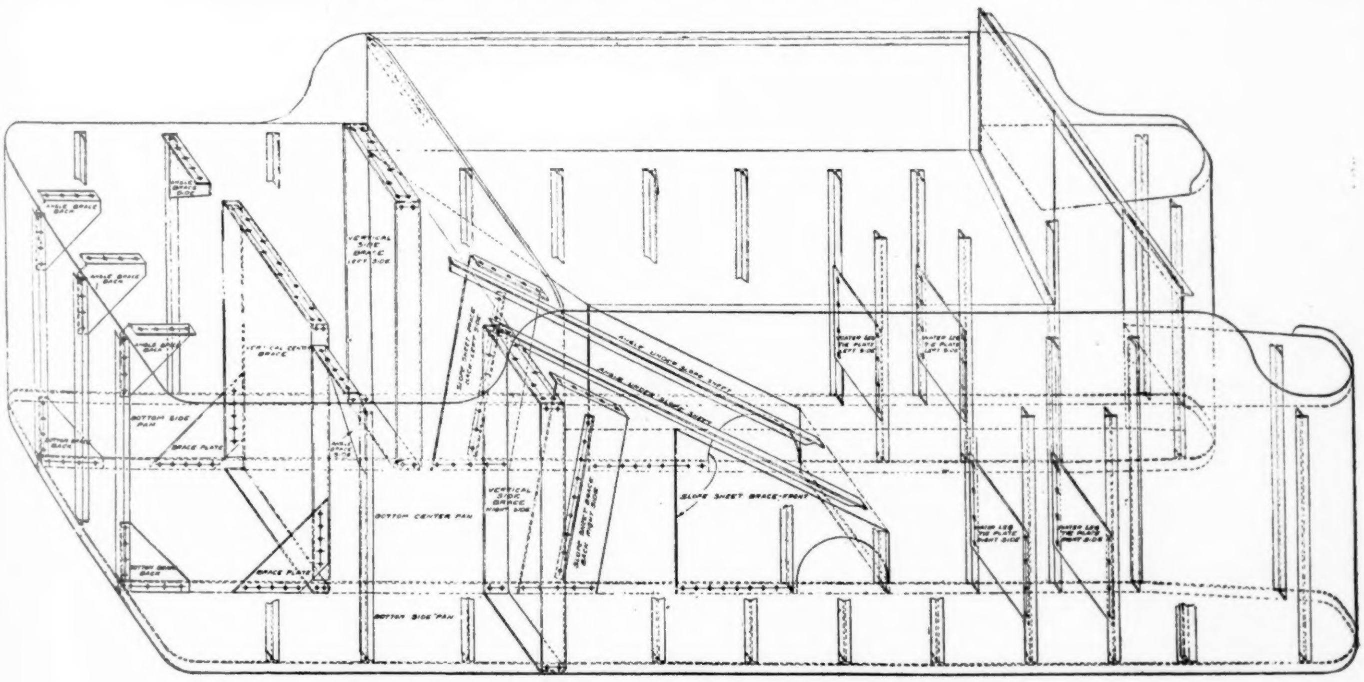
The object of bracing locomotive tenders is to make them sufficiently strong to stand the stresses that take place when the engine is in motion and to prevent the sides and back of the tank from bulging outward. To do this braces are applied on the interior of the tank, and anchor lugs are provided to stop the tank from moving on the tender frame.

What then is the best method of doing this work? Our opinion is the application of T-bars 3 in. by 3 in. by ⅜ in. on sides and back spaced about 24 in. apart in a vertical position, the length of the bars to be equal to the height of the tank from bottom to top, these bars to be riveted with not less than ⅝ in. diameter rivets spaced about six inches apart, zigzag.

The top of the tank at the rear end is braced by the application of T bars riveted to the under side with gusset plates rivetted on the ends. The slope sheet in the coal space is braced by the application of two T bars riveted to the under side, also supported by stay plates placed vertically and riveted to slope sheet and the tank bottom reinforced by angle bars. Dasher or splash plates of ¼ in. or 5/16 in. thickness are used for the purpose of frustrating the rush of water in the tank; they also form a brace for the top and bottom of the tank. One plate is placed in the center between the coal slope sheet and the back of the tank. Two plates are placed on each side, these are riveted to the top and bottom of the tank. The center dasher plate is flanged on the sides and riveted to the top of the tank, also gusset plates are applied at the bottom and riveted, which gives the dasher plate added strength. In order to make a permanent job all braces used in the construction should be riveted and not bolted.

This method of bracing is recommended for all rectangular tanks made from steel plates of 5/16 in. thickness or less, because it gives better service than the old method of applying longitudinal angle iron bars with cross stays. Also it has the tendency to eliminate leaky rivets in anchor lugs. We are of the opinion that when *weight* is not taken in account when designing locomotive tenders if the tanks were made from heavier material, say steel sheets ⅜ in. thick, it would greatly simplify the matter of bracing as heavier material could be used which no doubt would be more satisfactory. However, with ¼ in. plates for tank sides and top, and 5/16 in. plates for the bottom of the tank this is the best method of bracing, as it braces the tank in all its principal parts, and still leaves plenty of space on the interior so that the inspector can move around easily to make his inspection or repairs when necessary.

The report was signed by Thomas Lewis (L. V.), chairman; E. J. Sweeney (N. Y. C.), J. J. Orr (D. L. & W.), J. P. Malley (St. L. & S. F.) and J. T. Johnson (A. T. & S. F.).



Recommended Method of Bracing Rectangular Tenders

DISCUSSION

The superiority of vertical over horizontal braces was generally conceded. One of the principal sources of trouble reported was the loosening of the transverse braces. This

can only be overcome by good workmanship and by substituting rivets for bolts in these parts.

ACETYLENE WELDING

The committee in presenting this paper realized that this topic has been before the convention for several years and has been thoroughly threshed out by the members. We find it at this time very difficult to write up any new facts on this subject. However, we believe the following information will be beneficial.

APPARATUS

Many shops a few years back were equipped with portable generators, using what is termed "high pressure." Later, new apparatus was installed and shops were piped throughout for the acetylene and oxygen, using low pressure, which at this time is in pretty general use throughout the United States. A number of shops still use the oxygen and acetylene gas furnished in holders with the oxygen holders containing 1,800 to 2,000 lb., and the acetylene holders from 200 to 250 lb. pressure. With this method it is necessary to have different regulators for the oxygen as well as the gas for each wolder. But where the low pressure system is used, it is only necessary to have the regulators where the gas is generated and the oxygen manifolded. It is the opinion of the committee that the low pressure system piped throughout the different departments will give the best results.

WELDING TORCHES

There are several different makes of welding torches on the market, and while they will all do good work with an experienced operator, some torches are more quickly regulated and do not back-fire as readily as some other makes. In most all cases the welding tips are made of copper and give much better results than the brass.

CUTTING TORCHES

Many different styles of cutting torches are on the market. Some will back-fire readily, where with others it is almost impossible to make them back-fire, and in some cases both with the welding and cutting torches where they do back-fire, can be ignited quickly from the heated iron without readjusting; while, with other makes, it is necessary to shut off and start all over. This causes a loss of time as well as a waste of material.

Different methods are seemingly getting good results. The Chicago, Milwaukee & St. Paul are welding in all side sheets, bolting up securely, and applying stay bolts and rivets before welding. Cross-seams are welded by removing rivets, scarfing down, and welding up all holes and not removing any stay bolts. Door collars, inside and out; three-quarter door sheets, one-half flue sheets, top or bottom; full flue sheets; front sections of crown sheet; bottom patches of front flue sheet, 12 in. to 20 in. high, are all welded and all stay bolts and radial stays are cut off with the torch. In fact, we are doing everything in the line of welding we may find to do, and the sheets we are welding are standing up well and giving us no trouble. The only trouble at times is welding in patches in old side sheets, or where side sheets go to pieces rapidly due to poor water conditions. Where engines are in bad water territory, sheets do bulge between the bolts and at times the weld is pulled in two.

In the different railroad shops on such work as applying fireboxes, side sheets and door sheets, the welding in most cases is being done with the acetylene torch. Shops visited had both the acetylene and electric welding outfits, but were using the electric outfit mostly for welding flues, mud ring corners and roundhouse work, where the portable electric welding outfit will give good results.

Electric welding outfits have been installed for welding in all flues, mud ring corners, side sheets, cutting out the center and welding in new without removing mud ring rivets. It is also planned to do considerable firebox and boiler work with the electric welder, where flanges on front or back flue sheet are still good, cutting out the center and welding in new.

The report was signed by Henry J. Wandberg (C., M. & St. P), chairman; L. M. Stewart (A. C. L.), J. J. Davey (Nor. Pac.), John Harthill (N. Y. C.), P. F. Gallagher (B. & O.), and T. F. Powers (C. & N. W.).

DISCUSSION

The discussion brought out a great diversity of opinion regarding the advisability of welding firebox seams. Some condemned the practice as unsafe, while others contended that with proper care welded seams could be made stronger than riveted seams.

Some roads reported good results from welded tubes, others that the use of this practice had been a failure because of cracks in the bridges of tube sheets. All agreed that experience was essential for the production of satisfactory work. Some roads check the ability of welders by requiring weld specimens regularly each month; these specimens are then broken in a testing machine.

PROPER METHODS OF THREADING RADIAL STAYS AND TAPPING THE HOLES

The theoretical way to thread a radial stay is to make its thread align with the tap with which the holes in the crown and roof sheets are tapped. Experiments have proved that no better results are obtained from this method than where no attention was paid to the alinement. This is due to a slight variation in taps and threading machines and the tendency of the tap when tapping the roof sheet to assume a radial position in relation to roof sheet.

A practical method of tapping the holes is to use a double ended tap. However, good results are obtained with single ended spindle taps. It is very necessary that the tapping and applying of radial stays should have the same consideration as stay bolts in side sheets. The holes should be tapped with a suitable length tap so as to make a continuous thread. Radial bolts should be threaded in a machine equipped with a lead screw. If this is done there will be no trouble with entering bolts in crown sheet, on account of stripped threads.

The report was signed by H. J. Raps (I. C.) chairman and J. J. Keogh (C. R. I. & P.).

DISCUSSION

The threading of holes for radial stays from the outside was considered advisable due to the fact that the hole in the sheet next to the motor was slightly enlarged, and, if on the inside of the fire box it was difficult to make a tight joint. Practically all the members were of the opinion that it was a waste of time to try to get the same lead on the tap and on the stay as the variation in lead could not exceed half a thread or 1/24 in., which was easily compensated by the spring of the sheet.

CUTTING OFF STAYBOLT ENDS

In a shop that is equipped with crane facilities, where boilers are removed from frames and can be turned in any position, nippers can be used to good advantage. However, complaints have frequently been heard that the nippers do not make a good even end to drive, and it is very often necessary to go over the bolts and trim them with a chisel before driving. The use of the chisel in cutting off stay ends can hardly be considered, as it will damage the thread on the bolt and in the sheet; it also elongates the holes.

We believe the acetylene is so far superior to this method that there is hardly any room for discussion. In using the oxy-acetylene process the bolts can be cut to a uniform length,

with the boiler in any position. It leaves the bolt annealed for driving. In shops that are not provided with crane facilities, for boilers with narrow fireboxes, for cutting off scattered bolts, bolts applied in patches and radial stays, or where the boiler is on the frames and in an upright position and the bolts are applied from the inside, we believe the acetylene has no equal. The difference in cost will depend a great deal on the operator.

The report was signed by W. S. Larason (H. V.) and J. B. Tynan (W. & L. E.).

CO-OPERATIVE RESEARCH AND THE FUEL PROBLEM*

BY CAPTAIN O. S. BEYER, JR., U. S. A.

The influence of such fundamental items of railway operating expense as the cost of fuel and labor on the direction of developments, both mechanical and economical, in the industry has always struck me as a most important subject for consideration. When practices of locomotive and car construction or train operation of America are compared with those of Europe, striking differences are revealed. Intensive studies of the effect of basic cost items indicate more clearly than anything else the reasons why, for instance, the superheater, the mechanical stoker, the brick arch, the feed water heater, as well as the composite modern types of American locomotives themselves, assume tendencies in this country differing quite markedly from analogous tendencies in other countries. In fact, I do not think it an exaggeration to say that the whole course of American railway development is greatly influenced by the cost of fuel and labor. The problems created by the railway labor and fuel situation have a large economic background, which is very fundamental in its relation to the whole transportation industry. An analysis of this phase of the problem is a big subject in itself and cannot be elaborated here. Certain elements of the problem, however, are amenable to certain forms of solution which are becoming more and more important. Briefly, these particular solutions may be characterized as possible methods for increasing the productivity of the agencies creating the operating cost in question. To increase, as it were, the yield of fuel, to get more out of every pound, to utilize it more efficiently, is of more importance today than it ever was, and will become more and more so as each increment added to its cost places an additional premium on its efficient use.

The time has come, in my estimation, to survey the railway fuel situation, its problems and possibilities, with a thoroughness never attempted before. This association has succeeded, after several years of strenuous effort, in effecting a co-operation between many interests, whereby a piece of fuel research was accomplished which undoubtedly some day will be considered the inception of a movement contributing most extensively to the solution of the present-day railway fuel problem.

Since the committee on Fuel Tests handed in its report on the Test of Six Grades of Coal from a Franklin County, Illinois, Mine, at the 1917 convention, much has transpired. We have come to realize, as never before, the true significance of the scientific method in the solution of the problems in our industries, as compared with the slow, dull, expensive practices of cut and dry, rule-of-thumb, or by whatever other term the awkwardness of much of the industrial progress of the past might be characterized. Perhaps no other event of international importance than the war for democracy has served to emphasize this so well. A new realization has developed among scientists, engineers, administrators, statesmen, concerning the value of the *scientific method* in the solution of industrial problems.

*Abstract of a paper presented before the convention of the International Railway Fuel Association at Chicago, May 19-22, 1919.

It is my intention to point out as far as this association is concerned that its greatest opportunity lies in the direction of continuing and developing as rapidly as possible the lead it took when, through its Committee on Fuel Tests, it brought together the many interests and secured the necessary funds which eventually made possible the report already mentioned. This was but a beginning and a beginning under most adverse circumstances. As all this is indicative of what co-operation in research really means, the question which arises is, what can be done in this direction on behalf of contributing to the solution of the railway fuel problem? The Fuel Conservation Section of the United States Railroad Administration thoroughly appreciates the activities of this association. The extensive fuel and locomotive test facilities, but so meagerly used, at the Illinois, Iowa and Purdue experiment stations need but to be referred to. It seems, therefore, that the whole question reduces itself to one of initiative with the International Railway Fuel Association.

All these remarks would perhaps have little appeal were there not many important railway fuel problems pressing for solution. Consequently, in support of the remarks I have made above, the following fuel investigations, which can only be carried on in a sufficiently comprehensive way by co-operative research, are submitted for consideration by way of conclusion:

(a) *The Chemistry of Combustion.*—The theory of combustion as it exists today, applied to the burning of locomotive fuel, is incomplete, and fails to explain the occurrence of some very important phenomena, especially with reference to fires of varying thicknesses, clinkering, coking, the nature of the higher hydrocarbon products of combustion, etc.

(b) *Firing Practices.*—The purpose of this should be to determine the most economical combination of practice, devices and kinds of fuel in different territories possible. Maximum boiler capacities resulting from these combinations as well as relative smoke production should be determined.

(c) *Heat Absorption.*—A detailed experimental, as well as mathematical study of the process of heat transfer in the locomotive boiler should be made, especially with reference to the distribution of the heating surfaces between tubes, flues, combustion chamber and firebox.

(d) *Chemical and Physical Nature of Exhaust Gases.*—A splendid opportunity exists to investigate the products of combustion as they appear in the locomotive front end after they have done their work. The results might go a long way towards explaining the mysterious "unaccounted for" losses in the heat balance.

(e) *Accurate Smoke Measuring and Indicating Devices.*—Jointly with the foregoing investigation, attempts should be made to develop accurate smoke measuring and indicating devices.

(f) *The Drafting System.*—An investigation of the entire drafting system of the modern locomotive cannot be made too soon. The proportioning of ash pan opening, grate opening, gas areas between the end of the arch and the door sheet, of flues, tubes, and superheater damper, the space under the smoke box diaphragm, and the smokestack should all be carefully determined and general values for them expressed in empirical formulae having a wide range of application. This is far from accomplished today.

(g) *The Law of Resistance to Flow of Gases.*—Detailed study of the flow of gases through the locomotive boiler reveals possibilities for reducing their resistance to flow and perhaps at the same time suggests ways for effecting greater interchange of heat between these gases and the heating surfaces.

(h) *Radiation Losses.*—Very little is known about this important item, and in consequence losses resulting there-

from are thrown in with those considered as "unaccounted for." It is entirely possible to develop data on this point, especially with the perfected methods of pyrometry now in existence.

(i) *Locomotive Feed Water Heating.*—After a long period of development, the locomotive feed water heater is at last becoming available. As it stands today, it is perhaps one of the finest examples of the results of scientific experimentation applied to the solution of locomotive problems. The good work, however, should not stop. As long as feed water can be heated to still higher temperatures, as long as there are heat units still going up the stack which might be saved, the feed water heater investigation should continue.

(j) *Locomotive Boiler Performance.*—The whole general subject of locomotive boiler performance needs more study. Unfortunately the available reliable test data covering a sufficient range of performance is entirely too limited for this purpose. Consequently little opportunity exists for developing an extensive and well founded theory for locomotive boiler design.

(k) *Further Study of the Superheater.*—The superheater deserves further investigation. The work done at Purdue and especially at Altoona with varying lengths and diameters of superheater units has certainly contributed most valuable knowledge on this subject. As a continuation of this work the correlation between degree of superheat and boiler pressure as reflected in the steam economy of the engine should be worked out over wider ranges and mathematical determinations verified. Another very important question coming within this field is the effect of varying degrees of moisture in the steam entering the superheater.

(l) *Fuel.*—Investigation concerning fuel should primarily contemplate securing data on the relative steaming values of the fuel used in the railway service as determined from a complete series of boiler performances as well as maximum evaporative capacity tests. The data should also include information on the spark and smoke production of the various coals and their clinkering and honeycombing qualities, in order, if possible, to tie up practical performances of coals with the characteristics indicated by proximate and ultimate analysis and other laboratory tests of selected samples. The fuels which should thus be investigated are: (1), Typical coals from all important mining districts; (2), various commercial sized and some specially sized coals; (3), land stored, water stored and freshly mined coals; (4), powdered bituminous, anthracite, lignite and peat, together with combinations thereof; (5), oil, lignite, anthracite and bituminous coals, coke, peat, briquets and possible mixtures of these fuels.

Complete information as outlined would enable the railroads more clearly to specify desirable and necessary characteristics of fuel and to select fuels with far more intelligence than can now be done. It would enable them to determine with much greater accuracy the actual value of the various fuels available instead of solving this vital question by the unscientific methods now employed of "collective bargaining" between coal salesmen and fuel or purchasing agents. Some tests have been made to determine the relative steaming value of and the maximum capacity obtainable from certain typical locomotive coals and a limited number of different sized coals. One railroad, which has developed this data for coal used on its lines, has effected economies which have paid in one year over tenfold the cost of making the experiments.

It is entirely possible mechanically to prepare fuel in a highly pulverized form and burn it in a locomotive furnace. The machinery for doing this has been devolped and used with success. The next logical step is to determine accurately just what is the complete economic value of the utilization of pulverized fuel. The many general advantages which are bound to follow its use are, of course, recognized, but it is not known how much, for instance, the evaporation per pound of coal is increased at different rates of combustion. The heat balances over the complete range of boiler capacities of a few typical boilers fired with pulverized fuel have yet to be compared with the balances of these same boilers fired with ordinary fuel. And lastly, values as exactly as possible of the increase in capacity of the pulverized fuel fired boiler should be established. It is not yet possible completely and finally to judge the wisdom either of attempting to perfect or of widely introducing this system of combustion.

GAS WELDING SPRING BANDS

The cost per piece is a most important factor in determining the best process of welding when a large number of similar parts are required. For welding spring bands the oxy-acetylene process has given good results at the Rocky Mount shops of the Atlantic Coast Line.

The bands are formed to the required shape with a V-joint at one of the small sides and the welding done as shown in

Welding Spring Bands At Rocky Mount

the illustration. One operator welds five bands per hour at an average cost of 30 cents each for labor and material. Before the oxy-acetylene process was used these bands were welded at the forge, a blacksmith and helper welding two bands per hour at a cost of 57 cents each. A saving of 27 cents per band is thus effected.

FIVE YEARS WANDERING IN THE WILDERNESS.—Pacific Electric box car 2586, which left the builders, American Car & Foundry Company, St. Louis, Mo., December, 1913, arrived on home rails (first appearance) May 18, 1919. It had made seventeen trips between the Middle West and Eastern States, three between Atlantic and Pacific ports, one trip between Colorado and Eastern states and two trips between Eastern states and Texas. On one road it stayed 108 days; another it visited nine times in one month. This is the last to arrive of ninety box cars bought in 1913.—*Pacific Electric Magazine.*

NEW DEVICES

A DEVICE FOR BREAKING IN LOCOMOTIVES

A device designed to permit the breaking in of a new or repaired locomotive on a short length of track near the shop is described in a patent granted to A. C. Hinckley, superintendent of motive power and machinery, of the Oregon Short Line at Pocatello, Idaho. It consists of a bracket attached to the locomotive frame and supporting a small oil reservoir having a discharge pipe extending down close to the rail directly in front of the wheel. The reservoir is filled through a hole in the top, and a valve located in the discharge pipe controls the flow of oil to the rail. When the device is used on oil-burning locomotives it may be connected to the oil tank, thus insuring a constant supply of oil without the necessity of refilling the reservoir.

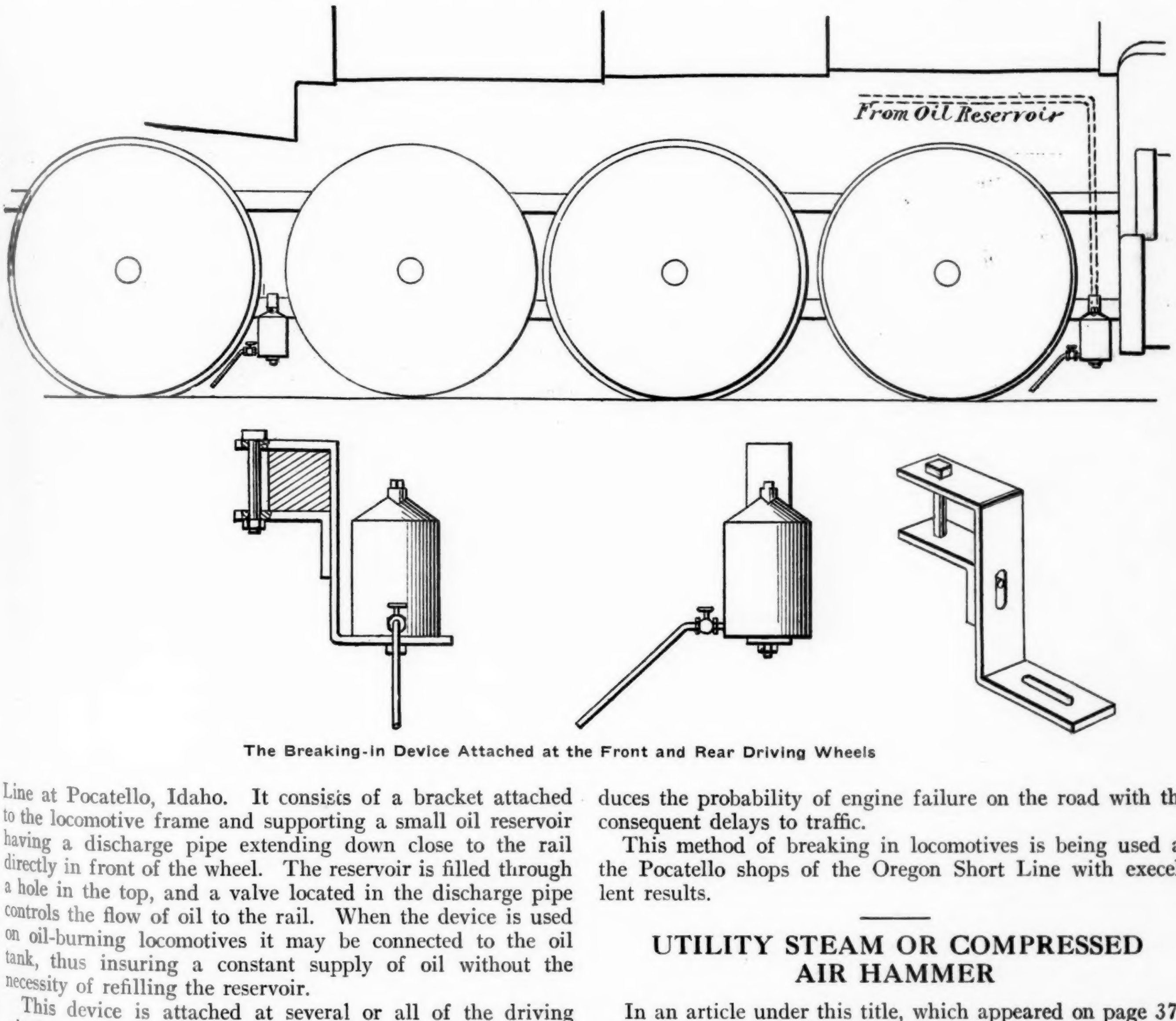
This device is attached at several or all of the driving wheels and by means of the discharge of oil on the rail, under the wheel tread, causes them to slip and rotate rapidly but, because of the lack of adhesion of the wheel and the rail, the locomotive is moved along the track at a very slow speed.

By its use the driving wheels may be revolved at a speed equivalent to forty miles per hour while the locomotive itself does not move along the rack at more than three or four miles per hour.

This gives the same effect as a break-in trip in service and being near the shop at all times permits immediate adjustment as the operation of the locomotive indicates it may be necessary.

Breaking in and making adjustments at the terminal reduces the probability of engine failure on the road with the consequent delays to traffic.

This method of breaking in locomotives is being used at the Pocatello shops of the Oregon Short Line with execellent results.



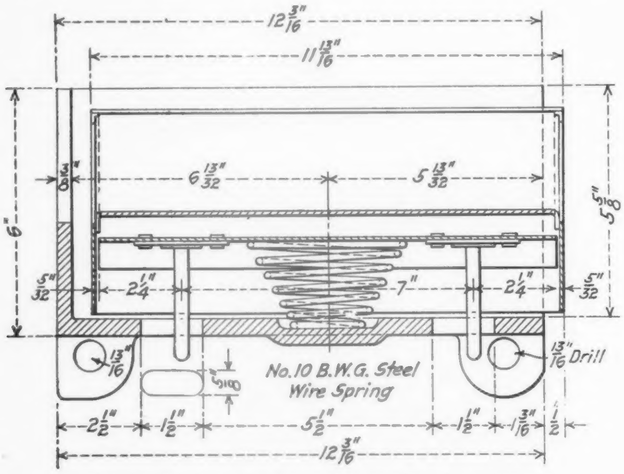
The Breaking-in Device Attached at the Front and Rear Driving Wheels

UTILITY STEAM OR COMPRESSED AIR HAMMER

In an article under this title, which appeared on page 372 of the June issue of the *Railway Mechanical Engineer*, the hammer was incorrectly described as a 30-in. Cincinnati special forge, operated either with compressed air or steam. The hammer should have been described as a general utility forge hammer which uses either compressed air or steam. This hammer is the product of the Sullivan Machinery Company, Chicago, Ill.

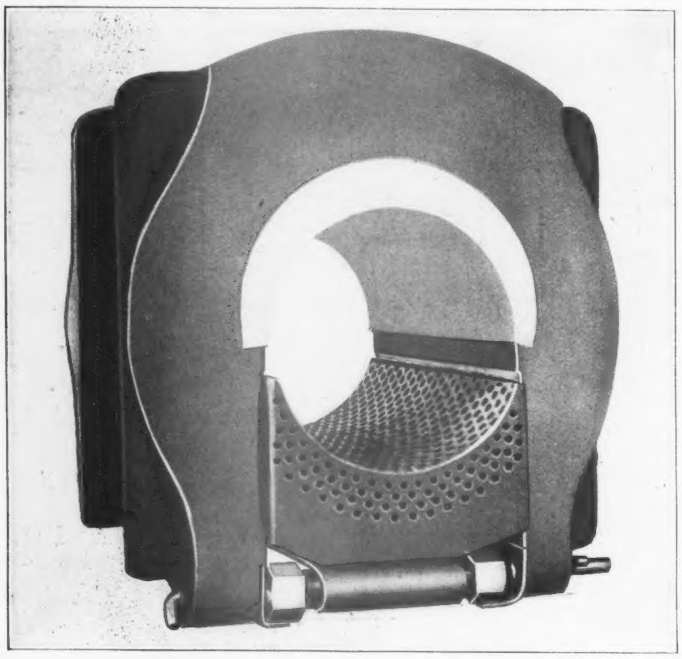
GREASE LUBRICATION OF LOCOMOTIVE DRIVING WHEEL HUBS

Excessive lateral motion between driving wheel hubs and driving boxes is a very serious defect as it is costly to repair and necessitates taking the locomotive out of service for a considerable period. The report of the chief inspector of locomotives for 1918 shows that 1,432 locomotives were taken out of service by federal inspectors for this defect alone.



Cross Section of Journal and Hub Lubricator

Despite the expense caused by excessive lateral motion and the fact that heating of the hubs is regarded as a frequent cause of overheated journals, the lubrication of driving wheel hubs is usually left to take care of itself. In order to overcome the objectionable conditions mentioned, a grease lubricator which feeds the lubricant to the hub face as well as the journals has been developed by I. Scranton, Decatur, Ill.



Sheet Steel Cellar for Locomotive Driving Box

The device consists of two perforated plates, one to fit the journal and the other to bear against the hub liner. The grease rests on a solid plate inside the perforated plates and is supported by a coil spring which sets in a recess in the cellar and holds the plate against the journal and the hub, as shown in the drawing.

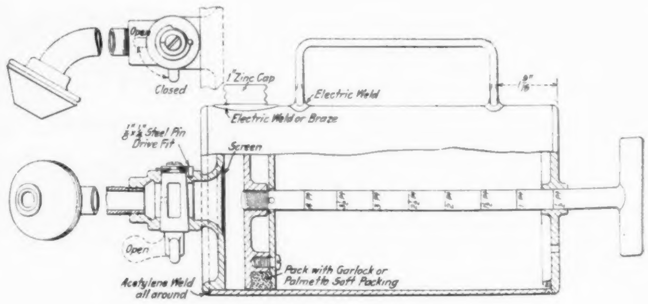
A recent improvement in the construction of the Scranton hub lubricating device consists in the elimination of the cast cellar. Two spreaders are used to form a base for the grease cellar to rest on, these being held in place by the usual cellar bolts. Fastened to the spreaders is a sheet which has a recess in which the supporting spring rests. Doing away with the cast cellar allows the perforated plate to come up higher on the journal, increasing its width 3 in. on a journal 10 in. in diameter and also increases the area of the sheet which lubricates the hub. The use of the spreader eliminates the trouble due to the box closing in on the cellar and facilitates the removal of the cellar. The Scranton hub lubricating device has been applied to several types of locomotives on the Wabash and service tests have shown that it reduces the lateral wear on driving boxes and hubs from 25 to 40 per cent.

A CYLINDER LUBRICATOR FILLER

A practicable lubricator of simple construction is the invention of G. W. Sturmer, a locomotive engineer, of Baltimore, Maryland, to whom a patent covering it has been granted. It consists of a cylindrical container having its interior surface finished to receive a piston which is attached to a rod passing through the cylinder head at one end and having a handle on its outer end. A packing held in place by a follower bolted to the piston gives a close contact to the cylinder walls. A handle is welded to the container body.

The central delivery passage, formed integral with one of the heads, is fitted with a delivery cock having an operating handle. A flexible filling pipe is attached to the outer end of the delivery passage and is provided with a nozzle fitted with a conical washer of compressible material. The supply opening is located in the body wall at the delivery end and can be tightly closed by a removable screw cap.

To operate the filler the piston rod is drawn out, (an atmospheric relief opening in the cylinder head permits this to be done easily), so that the graduations on the rod indicate that the volume of the space between the piston and the delivery cock is sufficient to contain the quantity



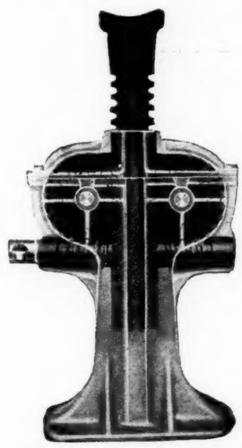
Lubricator Filler With the Delivery Cock Closed

of oil desired. The oil is then poured in through the supply opening, the screw cap replaced and tightened and the nozzle inserted in the filling hole of the lubricator. The piston is then pushed in, thus forcing the oil into the lubricator. A strainer of fine wire gauze placed over the inlet to the delivery passage prevents any foreign matter from entering the lubricator.

This filler provides an accurate, economical and safe means of filling a lubricator, as the graduations on the piston rod indicate the exact amount of oil delivered. The pressure on the piston, with the close contact of the conical washer at the lubricator, insures a constant flow of oil with a reduction of the waste experienced when filling a lubricator from a can and at the same time protects the operator from steam leakage through the lubricator throttle.

DOUBLE WORM DRIVE LIFTING JACK

A new type of lifting jack is being manufactured by the Iron City Products Company, Pittsburgh, Pa., which is known as the Rees Double Worm Drive Lifting Jack. In-



Cross Section of Rees No. 1 Jack

stead of a single worm gear pinioned to a lifting bar the double worm principle is employed. In this design right and left hand worms are cut on the worm shaft, which mesh with

General Purpose Jack

right and left hand worm gears carrying heavy pinions. The lifting bar, which has a set of teeth on either side, is located between the pinions and is raised or lowered by the double

Car Journal Jack

action of the two gears with extremely small effort and without the loss of power due to the friction that is caused by an unbalanced thrust on the worm shaft and lifting bar.

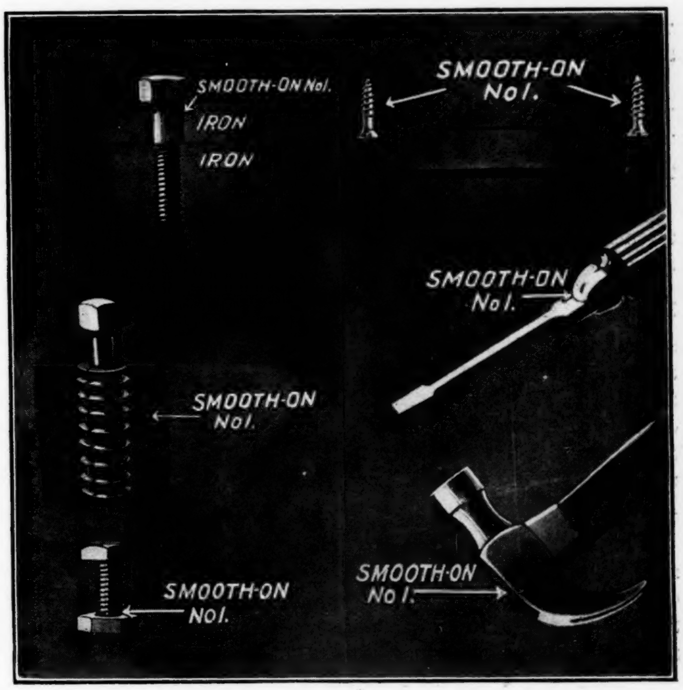
A number of different sizes and capacities of jacks designed with the double worm drive are being made. The car and general purpose jacks are made in a number of different heights and capacities, rating from 10 to 25 tons, while the jack shown in the sectional view is made in three heights, 9 in., 10 in. and 11 in., all having a rated capacity of 25 tons.

The simplicity and strength of construction of these jacks and the small number of working parts adapt them to rough usage, as there are only four working parts and no small parts to get out of order.

HANDY KINKS WITH IRON CEMENT

Some unique uses to which Smooth-On iron cement has been put are described by the Smooth-On Manufacturing Company, of Jersey City, N. J., and are shown in the illustration. This cement expands as it hardens and it is this property which makes it effective for the following applications.

The handles of hammers, which have become cracked and loosened may be strengthened and securely fastened in the tool by the use of Smooth-On. The cement is mixed with water to the consistency of putty and the handle dipped in it until that portion of the handle which enters the tool is covered and all the irregularities and cracks completely filled



A Number of Convenient Uses for Iron Cement

with cement. The inside surface of the hammer head is then thoroughly covered with cement and the handle pressed in. After wiping off any surplus cement and allowing the cement to harden, the hammer is ready for use. The handles of chisels, files, screw drivers and other tools may be treated in a similar manner.

A method of securing expansion bolts or screws in concrete or a brick wall is also shown. A hole considerably larger than the bolt or screw is drilled and filled with cement. The bolt or screw is then inserted, twisting it as it is pushed in, and the cement allowed to harden before placing any weight upon it.

As a substitute for a lock nut or a lock washer this cement may be applied as shown in the top and bottom left hand illustrations. The cement must always be allowed to harden before any use is made of the parts so treated.

Railway Mechanical Engineer

(Formerly the RAILWAY AGE GAZETTE, MECHANICAL EDITION with which the AMERICAN ENGINEER was incorporated)

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WE GUARANTEE, that of this issue 10,000 copies were printed; that of the 10,000 copies 9,000 were mailed to regular paid subscribers, 80 were provided for counter and news company sales, 206 were mailed to advertisers, 27 were mailed to employees and correspondents, and 687 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 62,610, an average of 6,659 copies a month.

THE RAILWAY MECHANICAL ENGINEER is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.).

The new shops of the Pullman Company at Ludlow, Ky., were destroyed by fire on the night of May 20, together with six sleeping cars; estimated loss, $225,000.

The new shops of the Canadian National at Leaside, near Toronto, Ont., were opened for business a few weeks ago. The plant consists of a roundhouse, powerhouse, administration building, locomotive repair shop and car repair shop.

The use of heavy guns on railroad cars is engaging the attention of officers of the War Department at Washington in connection with their studies of the defenses of the Chesapeake bay district. Coast artillery officers are now conferring with railroad officers regarding the practicability of constructing permanent spurs from the main lines to the coast around Chesapeake bay. The vicinity of Roanoke, Va., is also being studied in connection with its importance to the defense of the national capitol. Several heavy howitzers and rifles mounted on cars already are available, other units are under construction and still others will be brought back from France.

The Federal Board of Vocational Education has issued a 35-page pamphlet, for the benefit of disabled soldiers, sailors and marines, telling what kinds of work they may be able to find in the field of transportation, including steam railroads, street railways, wagons, automobiles and ocean steamships and harbor craft. The government stands ready to educate and re-educate disabled men, and the educational department in the military and naval hospitals will give inquirers all needed information. This pamphlet is designed to aid individuals in choosing a vocation. It tells what kind of work must be done, and what qualifications are required, in the case of telegraphers, train despatchers, station agents and other station workers, yardmasters, clerks, ticket examiners and traffic department employees; shop work, boiler making, blacksmithing, electrical work and car repairs; track work and train work. The work on electric railways and on ocean and harbor vessels is described in the same way. The Federal Board of Vocational Education, which is ready to give all possible aid to disabled soldiers, has offices in Boston, New York, Philadelphia, Pittsburgh, Baltimore, Washington, Atlanta, New Orleans, Dallas, St. Louis, Cincinnati, Chicago, Detroit, Kansas City, Minneapolis, Denver, San Francisco and Seattle.

MEETINGS AND CONVENTIONS

New York Electrical Society.—Edwin B. Katte, chief engineer of electric traction of the New York Central, has been elected president of the New York Electrical Society. Mr. Katte was graduated from Sibley College, Cornell University, with the degree of M.E. in 1893, and with the degree of M.M.E. in 1894. He began railroad work on the New York Central & Hudson River in 1896. In 1903 he was appointed electrical engineer, which carries with it the secretaryship of the electric traction commission. In 1906 he was appointed chief engineer of electric traction of the New York Central & Hudson River. Mr. Katte is a past vice-president of the American Society of Mechanical Engineers.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

AIR-BRAKE ASSOCIATION.—F. M. Nellis, Room 3014, 165 Broadway, New York City.

AMERICAN RAILROAD ASSOCIATION, SECTION III—MECHANICAL.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

AMERICAN RAILROAD MASTER TINNERS', COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.—O. E. Schlink, 485 W. Fifth St., Peru, Ind.

AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.—R. D. Fletcher, Belt Railway, Chicago. Convention, August 27-29, Hotel Sherman, Chicago.

AMERICAN SOCIETY FOR TESTING MATERIALS.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

CAR FOREMEN'S ASSOCIATION OF CHICAGO.—Aaron Kline, 841 Lawlor Ave., Chicago. Meetings second Monday in month, except June, July and August, Hotel Morrison, Chicago.

CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.—H. J. Smith, D. L. & W., Scranton, Pa.

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.—A. L. Woodworth, C. H. & D., Lima, Ohio.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—J. G. Crawford, 542 W. Jackson Blvd., Chicago.

INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.—William Hall, 1061 W. Wabasha Ave., Winona, Minn. Convention September 2-5, 1919. Hotel Sherman, Chicago.

MASTER BOILERMAKERS' ASSOCIATION.—Harry D. Vought, 95 Liberty St., New York.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION OF U. S. AND CANADA.—A. P. Dane, B. & M., Reading, Mass.

NIAGARA FRONTIER CAR MEN'S ASSOCIATION.—George A. J. Hochgrebe, 623 Brisbane Bldg., Buffalo, N. Y. Meetings, third Wednesday in month, Statler Hotel, Buffalo, N. Y.

RAILWAY STOREKEEPERS' ASSOCIATION.—J. P. Murphy, Box C, Collinwood, Ohio.

TRAVELING ENGINEERS' ASSOCIATION.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio. Convention, September 16-19, Hotel Sherman, Chicago.

PERSONAL MENTION

GENERAL

C. I. Evans, chief fuel supervisor of the Missouri, Kansas & Texas of Texas, has been appointed chief assistant mechanical superintendent of the Missouri, Kansas & Texas and associate roads, with office at Denison, Texas, in charge of maintenance of equipment.

H. P. Anderson, mechanical superintendent of the Missouri, Kansas & Texas and the Missouri, Kansas & Texas of Texas, with office at Denison, Texas, has been transferred to the staff of the federal manager at St. Louis, Mo., in charge of executive and administrative matters of the mechanical department on the roads under the jurisdiction of C. N. Whitehead, federal manager, at St. Louis.

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

F. S. Kelly, master mechanic of the Louisiana division of the Texas and Pacific, with headquarters at Gouldsboro, La., has been transferred to Marshall, Texas, succeeding R. E. Roe, resigned.

W. L. Robinson, superintendent of fuel and locomotive performance of the Baltimore & Ohio, with headquarters at Cincinnati, Ohio, has been promoted to division master mechanic of the Illinois division, at Washington, Ind.

CAR DEPARTMENT

J. McWood has been appointed master car builder of the Grand Trunk, Eastern Lines, with headquarters at Montreal, Que., succeeding J. Hendry, assigned to other duties.

SHOP AND ENGINEHOUSE

Joseph Chidley, assistant superintendent of motive power of the New York Central, Lines West of Buffalo, at Cleveland, Ohio, has been appointed superintendent of motive power of the Lines West, succeeding D. R. MacBain.

D. R. MacBain, superintendent of motive power of the New York Central, Lines West of Buffalo, has been appointed assistant general manager of the Lines West, with headquarters at Cleveland, Ohio.

Herman F. Noyes, traveling engineer of the Maine Central, has been appointed superintendent of fuel economy of that road and the Portland Terminal, with office at Portland, Maine.

Charles J. Scudder has been appointed superintendent of shops of the Delaware, Lackawanna & Western, with headquarters at Scranton, Pa., succeeding Joseph Grieser assigned to other duties.

PURCHASING AND STOREKEEPING

W. C. Bower, purchasing agent of the New York Central, with headquarters at New York, has had his jurisdiction extended over the Lines West of Buffalo, succeeding G. R. Ingersoll, who has resigned to engage in other business.

Dwight C. Curtis, inspector of stores on the Chicago, Burlington & Quincy, with headquarters at Chicago, has been promoted to supervisor of stores of the Northwestern region, with the same headquarters, succeeding J. E. Mahaney, resigned to accept service elsewhere.

Horacio V. Garza has been appointed assistant purchasing agent of the National Railways of Mexico, with office at New York, succeeding F. P. de Hoyos, who was local purchasing agent. Mr. de Hoyos remains as general agent of the National Railways of Mexico as well as purchasing and general agent of the Southeastern Lines of Mexico.

SUPPLY TRADE NOTES

R. P. Lamont, president of the American Steel Foundries, Chicago, has authorized the announcement that a contract for the purchase of the Griffin Wheel Company has been signed.

Edward Walters, sales engineer for the American Steel Foundries, Chicago, has resigned to enter the employ of the Keyoke Railway Equipment Company, Chicago, as salesman, with headquarters at Chicago.

H. M. Davison, for the past 14 years connected with the sales organization of the Hayward Company, has left that company to become sales manager of the Ohio Locomotive Crane Company, Bucyrus, Ohio.

George W. Jones, assistant manager of the New York office of the Pittsburgh Steel Company, of Pittsburgh, Pa., has been appointed manager of the Chicago office, with headquarters in the McCormick building.

W. R. Gillies has resigned as mechanical engineer of the Oregon Short Line, with headquarters at Pocatello, Idaho, to enter the employ of the Union Asbestos & Rubber Company, Chicago, as assistant to the president.

The Bordon Company, Warren, Ohio, manufacturers of the Beaver die stocks and die cutters, has opened a downtown Chicago office at 549 West Washington street, in charge of Charles A. Green, Chicago representative.

The Duntley-Dayton Company, Chicago, has taken over the sales agency for the Red Devil rivet cutting guns, made by the Rice Manufacturing Company, Indianapolis, Ind., for all territory east of the Rocky mountains.

F. W. McIntyre, who for the past 16 years has been connected with the Niles-Bement-Pond Company in Boston and Chicago, has been appointed sales manager of the Becker Milling Machine Company, Hyde Park, Mass.

F. G. Echols, for many years general manager of the small tools department of Pratt & Whitney Company of Hartford, Conn., has accepted a position as vice-president of the Greenfield Tap & Die Corporation, of Greenfield, Mass.

The General Tool & Supply Company, Saginaw, Mich., has been appointed to represent the Cleveland Milling Machine Company in the Saginaw district, and will carry a stock of milling machines and a large supply of cutters.

The Niles-Bement-Pond Company, Pittsburgh, Pa., has removed its office from the Frick building to 425 Seventh avenue. The company has also opened a new office and store at 116 South avenue, Rochester, N. Y., and will keep a stock of Pratt & Whitney small tools at both places.

Edwin T. Jackman, formerly of E. S. Jackman & Co., Chicago, has returned from Sheffield, England, where he has been investigating methods in connection with tool and alloy steels. On July 1 he became manager of the Boston, Mass., office of the Firth-Sterling Steel Company, McKeesport, Pa.

The North American Car Company, Chicago, has purchased a 23-acre tract at 135th street on a joint right of way of the Indiana Harbor Belt, the Baltimore & Ohio Chicago Terminal and the Chicago, Rock Island & Pacific, on which a car construction and car repair plant will be built in the neart future.

W. E. Millar has been appointed Pittsburgh district manager of the Cleveland Milling Machine Company and L. H. Mesker, vice-president of the company, has turned over the duties of sales manager to H. I. Miner. The company also

announces that the J. Horstmann Company has been appointed French agent, under the personal direction of Henri Nourry.

George Shields, who was purchasing agent of the American Car Company, St. Louis, for ten years, and later served with the National Safety Car & Equipment Company since its organization, has become associated with The Dayton Manufacturing Company as sales representative, with headquarters at Dayton, Ohio.

The Allied Steel Castings Company, Harvey, Ill., which is controlled by the Chicago Malleable Castings Company and the Universal Draft Gear Attachment Company, Chicago, will install a 10-ton open hearth furnace to supplement the present Wellman-Seaver-Morgan 5-ton tilting furnace, which will be enlarged.

John T. Mahoney, purchasing agent of the Buda Company. Chicago, with headquarters at Harvey, Ill., has been promoted to sales manager of the truck and tractor engine department, to succeed Lon R. Smith, who has resigned to become general sales manager of the Midwest Engine Company, Indianapolis, Ind.

Joseph Robinson, formerly president of the Robinson Connector Company, Inc., announces that he is no longer connected with that company in any managerial capacity and has no supervision over the mechanical details of construction of the automatic hose connector, of which he is the inventor and which bears his name.

W. M. Carty, assistant superintendent of the American Brake Shoe & Foundry Company, Chicago, has been appointed superintendent of the Pine Bluff, Ark., plant of the Standard Brake Shoe & Foundry Company. The latter company recently purchased equipment to increase its capacity from 350 to 800 tons a month.

Major Charles E. Sholes has been elected vice-president, director and general sales manager of the Edison Storage Battery Company to succeed Harrison G. Thompson, who has resigned to organize and conduct the Transportation Engineering Corporation of New York. Major Sholes has heretofore been identified with the construction, operation and management of chemical industries. He was the active member of the Creditors' Committee of the Aetna Explosives, Inc., during the receivership. During the war he served as major in ordnance, first as chief of the chemical branch, which attended procurements of platinum, cotton linters, alcohol, acids, etc., and as army representative before the War Industries Board, and numerous other committees and boards. He was subsequently made contracting officer for the United States on the staff of Colonel Lamont, and retains his rank in the Officers' Reserve Corps. He is also chairman of the Society of Chemical Industry.

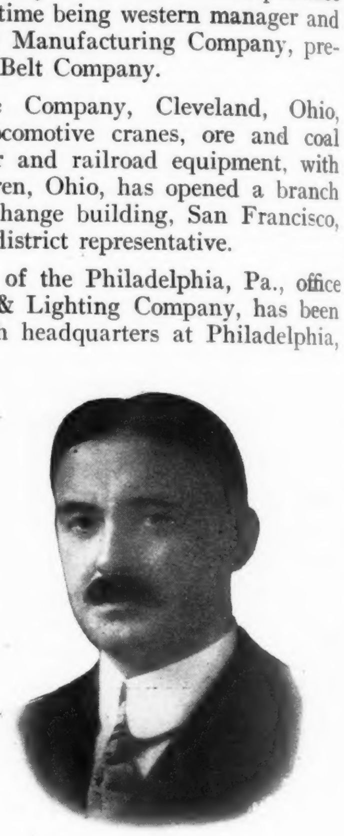

Major C. E. Sholes

Paul H. Schatzmann, foreign representative of the Joseph T. Ryerson & Son Company, is temporarily in charge of the company's interests in Brazil, Argentina and Peru. In August Mr. Schatzmann will sail for Europe, thence to India, China and Japan. A. L. G. Gentles will take care of the interests of this firm in Great Britain and Scandinavia, with headquarters in London.

Samuel F. Joor, consulting engineer of Chicago, has joined the American Steam Conveyor Corporation, Chicago, in the capacity of sales engineer. Mr. Joor has had wide experience in the conveyor field, at one time being western manager and sales engineer of the Jeffrey Manufacturing Company, previously being with the Link Belt Company.

The McMyler Interstate Company, Cleveland, Ohio, makers of car dumpers, locomotive cranes, ore and coal handling machinery, scraper and railroad equipment, with works at Bedford and Warren, Ohio, has opened a branch office in the Merchants Exchange building, San Francisco, Cal., with L. A. Somers as district representative.

W. L. Garland, manager of the Philadelphia, Pa., office of the Safety Car Heating & Lighting Company, has been elected a vice-president, with headquarters at Philadelphia, Pa. Mr. Garland was born in Blair county, Pennsylvania. He completed his apprenticeship at the Altoona shops of the Pennsylvania Railroad in 1892; he then served in various departments of the shops for five years, and later took up locomotive and car design. In 1901 he was appointed chief car inspector on the Pennsylvania Railroad. In 1907 he was appointed general agent of the Safety Car Heating & Lighting Company, and in 1909, was promoted to manager. Mr. Garland was commissioned a major in the Corps of Engineers and was assigned to the 87th Battalion, Military Railroads. He was released from active service on the signing of the armistice.


W. L. Garland

J. Stanley McCormack, formerly sales manager of the Bell Locomotive Works, Inc., New York City, will return to resume his old position on his discharge from the Naval Aviation Corps. Mr. McCormack enlisted at the outbreak of the war, training as a naval aviator, received his commission and was detailed to special experimental aviation development.

E. E. Maher has organized the Maher Engineering Company, with office in the Michigan Boulevard building, Chicago, to handle the sales and installation of Erie Engine Works high speed engines, Sims feedwater heaters, Dayton-Dowd centrifugal pumps, Wagner steam pumps and Pratt Engineering & Machine Company fertilizer and sulphuric acid machinery.

The Betson Plastic Fire Brick Company has been incorporated under the name of the Betson Plastic Fire Brick Company, Inc., with headquarters at Rome, N. Y. Frank J. Jewell is president and secretary, and Nelson Adams vice-president and treasurer. The company manufactures plastic fire brick for boiler furnace linings and baffle walls and "Hi-Heat" cement for use in boiler rooms.

Col. E. J. Hall, first vice-president of the Hall-Scott Motor Car Company, San Francisco, Cal., recently received the distinguished service medal from the government in recognition for designing the major portion of the liberty motor and also having an excellent record as chief of the Technical Section, Air Service, in charge of aviation engineering, inspection, and

acceptance of airplane parts and equipment with the A. E. F. in France, England and Italy.

The International Oxygen Company, Newark, N. J., has appointed Preston Belvin district sales engineer, in charge of the Pittsburgh district sales work, with office at 1310 First National Bank building, Pittsburgh, Pa. The Chicago office, in charge of Philip G. Wesley, has been removed from 223 Railway Exchange building to 817-820 Chicago Stock Exchange building, 30 North La Salle street.

The manufacturing facilities of the U. S. Light & Heat Corporation, Niagara Falls, N. Y., are to be increased by the addition of several buildings. The plant space now covers about nine acres and consists of 22 buildings. Recently two structures of brick and concrete were added. Contracts have been let and construction is already under way on the new buildings which will be of reinforced concrete and brick.

Marcel E. Cartier, sales engineer of the Joseph T. Ryerson & Son Company, Chicago, with headquarters at Paris, France, has returned to France after a few weeks' visit in this country. He will be joined in Paris by John H. Romann, sales engineer of the same firm. Messrs. Cartier and Romann will have charge of the company's business in France, Belgium, Holland, Switzerland, Italy, Spain and Portugal.

J. G. Carruthers, manager of sales of the Carnegie Steel Company, the Illinois Steel Company, and the Tennessee Coal, Iron & Railroad Company, with headquarters at Cincinnati, Ohio, has been appointed manager of sales for the Chicago district of the Illinois Steel Company at Chicago. He has been succeeded at Cincinnati by George H. Vant, who has been transferred from the Pittsburgh office of the Carnegie Steel Company.

The National Railway Appliance Company, New York, announce that by arrangement with Holden & White, Inc., Chicago, general agents, they are now prepared to offer in eastern and southern states a line of car heaters of all types. These include the Jewel hot blast forced ventilation stove, the hot water coal burning coil type, and a complete line of electric heaters, including cross seat, panel, truss plank and vestibule types.

Donald M. Ryerson, who for the past two years has been in the United States Navy, has received his discharge from the service and has returned to his duties as vice-president in charge of purchases and sales of the Joseph T. Ryerson & Son Company, Chicago. E. L. Ryerson, Jr., has also received his honorable discharge from the army, and has returned to the company as vice-president and works manager after nearly two years of absence.

E. A. Hitchcock has been elected vice-president of the Bailey Meter Company, Cleveland, Ohio. He will supervise the training of technical graduates for the company's service and sales departments. During the past six years he has been connected with the E. W. Clark & Co. Management Corporation as advisory, consulting and power sales engineer. Previous to that time he was professor of experimental engineering at Ohio State University.

J. W. McCabe, until recently district manager of sales at Buffalo, N. Y., for the Chicago Pneumatic Tool Company, Chicago, has been appointed special representative for the company's foreign trade department and will make an extended trip throughout the Orient, the Philippine Islands and Australia. W. H. White has been appointed acting district manager of sales at Buffalo to take charge of that territory during Mr. McCabe's absence.

Colonel R. P. Lamont, president of the American Steel Foundries, Chicago, has been awarded the distinguished service medal for "exceptionally meritorious service as assistant to the chief of the procurement division, later as chief of the procurement division and as a member of the claims board of the ordnance department," and for "rendering material assistance to the nation's industry in adjusting equitably outstanding contracts in full justice to employers and employees alike."

The Standard Car Construction Company and the Standard Car Equipment Company were merged on June 4, under the name of the Standard Tank Car Company, with head office and works at Sharon, Pa., and branch offices at New York, St. Louis and Chicago. John Stevenson, Jr., is president and G. F. Wood-Smith is vice-president of the new company, which will continue all the functions of the two companies, both as to the building and leasing of tank cars and all forms of steel plate construction.

The Buffalo Forge Company, Buffalo, N. Y., announces that Lieut. C. C. Cheyney has returned from service in the United States Navy, and is now in charge of its Chicago office and store. Lieut. Cheyney had charge of the mechanical repair shops at the naval aviation station, Pensacola, Fla., where from 500 to 1,200 men were employed during the war. Captain H. H. Downes, 12th U. S. Engineers (Railway), has returned from France, and after receiving his discharge expects to take charge of the Buffalo Forge Company's interests in the St. Louis territory.

The Bay City Foundry & Machine Company, Bay City, Mich., manufacturer of coal conveyors, saw mill machinery and hoists, has purchased the business of the Howlett Construction Company, Moline, Ill., manufacturer and builder of the Williams, White & Co., coaling stations. W. E. Howlett, manager and engineer of the Howlett Construction Company, will be manager of the railroad coaling station department of the consolidated company. This consolidation will unite the engineering facilities of the two companies and enable them to manufacture their own machinery.

The Central Steel Company, Massillon, Ohio, has opened new offices in Detroit, in the Book building, 35-37 Washington boulevard. Arthur Schaeffer, former assistant director of sales at the home office, Massillon, has been appointed district manager of sales, with Frank Gibbons as his assistant. Mr. Gibbons, who has just joined the organization, has been associated with the Carbon Steel Company for five or six years. He spent a great part of this time in the Carbon Company's Pittsburgh plant, and for the last several months has been district sales manager, with office at Detroit.

Tentative plans for a large increase in the capacity of the Pollak Steel Company, both at the Cincinnati and Chicago works, have been laid and are rapidly being worked out. D. E. Sawyer has been appointed general manager of sales, with headquarters at 120 Broadway, New York. Mr. Sawyer was formerly connected with the Illinois Steel Company, and was assistant steel director of purchases of the War Industries Board. The B. M. Parsons Company, 1001 Pioneer building, St. Paul, Minn., has been appointed northwestern sales representative in St. Paul, Minneapolis, Duluth and the Iron Range district.

The S. F. Bowser Company, Ltd., Toronto, Ont., which has for a number of years been manufacturing and selling Bowser gasoline and oil pumps, tanks and storage systems under the control of the parent company, S. F. Bowser & Co., Inc., Fort Wayne, Ind., has been re-organiezd under the Canadian laws to operate as a strictly Canadian firm. H. C. Christie, who has been for some time past connected with the Canadian factory of the S. F. Bowser Company, recently as sales manager, has been elected manager, with E. E. Cummings as factory manager. For a number of years, nearly the entire Canadian trade of the S. F. Bowser Company has been supplied from the Toronto factory, but this company has been under the direction of the home office at Fort Wayne. Through

the present re-organization, the Canadian factory is to be operated and controlled as a separate institution. The officers are S. F. Bowser, president; S. V. Bechtel, vice-president; H. J. Grosvenor, secretary, and W. G. Zahrt, treasurer.

American Brake Shoe & Foundry Changes

William G. Pearce has retired as president of the American Brake Shoe & Foundry Company to become chairman of the executive committee, and Joseph B. Terbell, vice-president, has been elected president to succeed Mr. Pearce. Randolph Ortman, who has been president for one of the company's subsidiaries, has been elected a director, succeeding the late Joseph D. Gallagher.

W. G. Pearce

William G. Pearce, chairman of the executive committee of the American Brake Shoe & Foundry Company, was born at Marietta, Ohio, on June 11, 1859. He entered railway service in August, 1877, as a clerk in the office of the controller of the Missouri, Kansas & Texas, at Sedalia, Mo. He was later promoted to bookkeeper and chief clerk in the same office, and in August, 1879, left that road to take a clerical position in the auditing department of the Northern Pacific. He was successively promoted to assistant express auditor, assistant auditor of disbursements and auditor of disbursements in the same department, and in February, 1890, was appointed general purchasing agent. From May, 1892, to September, 1896, he was assistant general manager of the same road, and when the Northern Pacific was reorganized on the latter date, he was transferred to Tacoma, Wash., as assistant general superintendent. From August, 1900, to July 1, 1901, he was assistant to the president of the Northern Pacific, the Seattle & International, and the Washington & Columbia River, at the same time being general manager of the Seattle & International. From July, 1901, to March, 1902, he was general manager of the Northern Pacific, leaving railway service at the end of that time to become second vice-president of the Griffin Wheel Company. On June 5, 1905, he was also made general manager of this company, with headquarters at Chicago. He left the Griffin Wheel Company on November 22, 1910, to become vice-president of the American Brake Shoe & Foundry Company, and in May, 1916, was elected president, with headquarters at New York.

J. B. Terbell

J. B. Terbell, the new president, was born at Corning, N. Y., in February, 1863, and was educated at Hamilton College, graduating in the class of 1884 with the degree of A. B. After leaving college he served with the Fall Brook Railway, now the Pennsylvania division of the New York Central, with headquarters at Corning, N. Y., and later was vice-president of the Corning Iron Works. In 1897, he became president of the Corning Brake Shoe Company, and in 1902, was elected vice-president of the American Brake Shoe & Foundry Company, with headquarters at Chicago, in charge of the company's western business. In 1915, Mr. Terbell came to the New York office in connection with munition contracts for the British government.

Transportation Engineering Corporation Organized

Harrison G. Thompson resigned from his position as vice-president and general sales manager of the Edison Storage Battery Company on June 1, 1919, and has incorporated the Transportation Engineering Corporation, with offices at 200 Fifth avenue, New York. The officers are as follows: H. G. Thompson, president; F. V. McGinness, vice-president, and Harold H. Smith, secretary-treasurer. The new corporation will act as railway distributors for the Edison Storage Battery Company and for the Automatic Transportation Company, of Buffalo, N. Y. It will handle the Edison storage battery for train lights, railway signaling, multiple unit control, and for other purposes to which storage batteries may be applied. It will also handle the complete line of industrial trucks, tractors, and industrial engines manufactured by the Automatic Transportation Company, with such apparatus as charging equipment and other supplies incident to the above lines.

H. G. Thompson

Mr. Thompson became associated with the Edison Storage Battery Company in 1910, and was elected a vice-president in 1913. He was born at Weston, Mass., in 1875. In 1896 he entered the service of the Pullman Company, and after two years was made foreman of electricians. In 1900 he resigned to become foreman of the battery department of the Riker Motor Vehicle Company, but left the latter at the time of its absorption by the General Vehicle Company, of Hartford, Conn., to become associated with W. L. Bliss, one of the pioneers in electric car lighting development. In 1905 he entered the service of the Pennsylvania Railroad and was placed in charge of electric car lighting, with headquarters at Jersey City, N. J. About one year later he became electrical superintendent of the Safety Car

F. V. McGinness

Heating & Lighting Company, New York, and was in charge of that company's electrical laboratories during the development of its first electric car lighting system. In December, 1909, he was appointed manager of the railroad department of the Westinghouse Storage Battery Company and later, for a short time, was in the employ of the United States Light & Heat Company, New York. In July, 1910, he became manager of the railway department of the Edison Storage Battery Company; in July, 1915, he was appointed general sales manager, and became also vice-president of the company in July, 1918.

Franees V. McGinness, who recently resigned as railway sales manager of the Edison Storage Battery Company, is vice-president of the new corporation. He graduated from Columbia University, School of Engineering, with the degree of electrical engineer in 1910, and then spent a short time in the engineering departments of the New York Telephone Company and the New York & Queens Light & Power Company. He became connected with the Edison forces in 1911, being then engaged in experimental work in Mr. Edison's laboratory. At this time he also reecived a thorough training in the manufacture of the Edison battery. He was later appointed assistant manager of the railway department of the Edison Storage Battery Company, and in March, 1916, he was promoted to manager of the same department.

Harold H. Smith, electrical engineer of the Edison Storage Battery Company, becomes secretary-treasurer of the newly formed Transportation Engineering Corporation.

H. H. Smith

Mr. Smith graduated from the Polytechnic Institute, Brooklyn, N. Y., in 1909, with the degree of E.E. For one year thereafter he was employed by the Pennsylvania Tunnel & Terminal Railroad, in the office of the chief engineer of electric traction, in connection with the New York electrification of the Pennsylvania Railroad. He then joined the staff of the laboratory of Thomas A. Edison, at Orange, and for several years was engaged in research work in connection with the Edison storage battery. Later he became connected with the selling department of the Edison Storage Battery Company in the capacity of engineer, and retained that position up to the time of his recent resignation.

The Stark Rolling Mill Company, Canton, Ohio, has appointed George W. Scott district manager for the Chicago territory, with headquarters at 1119 Marquette building. Mr. Scott was formerly Chicago representative of the Pittsburgh Steel Company. Thomas F. Murphy has been appointed district manager for the Canton territory. He was formerly connected with the American Sheet & Tin Plate Company.

The Metallo Gasket Company has recently been incorporated to manufacture gaskets and other packings, at New Brunswick, N. J., with the following officers: Zeno Schultes, president and treasurer; George Geipel, vice-president, and Stanley S. Geipel, secretary. Mr. Schultes was manager of the Goetze Gasket & Packing Company for about 14 years. George Geipel has been an erecting engineer for 35 years, specializing in refrigerating and steam power plants, and Stanley S. Geipel has had ten years' experience in mechanical engineering. The company will concentrate for a time on its metallo corrugated copper gasket with asbestos cord inlaid in the copper grooves or corrugations.

The Chicago Pneumatic Tool Company announces the election of Allan E. Goodhue as managing director of its English subsidiary, the Consolidated Pneumatic Tool Company, Ltd., whose offices are at 170 Piccadilly, London, and whose plant is in Fraserburg, Scotland. Mr. Goodhue will also have charge of European sales for the Chicago Pneumatic Tool Company. He was for a number of years connected with the sales department of the Midvale Steel Company and Midvale Steel & Ordnance Company in Philadelphia, Chicago and Boston, leaving that company in March, 1918, to enter the service of the government. From that time until January 1, 1919, when he became connected with the Chicago Pneumatic Tool Company, he was assistant manager of the steel and Raw Material Section, Production Division, of the Emergency Fleet Corporation.

Railway & Industrlal Engineers, Inc.

The Railway & Industrial Engineers, Inc., with offices at 25 Broad street, New York, recently organized by J. E. Muhlfeld and V. Z. Caracristi announces that it has associated with it an experienced, competent and reliable staff of experts thoroughly familiar with domestic and foreign methods and practices, and offers to bankers, corporations and others its services in a representative, advisory, consulting or administrative capacity as follows:

J. E. Muhlfield

Organization, management and operation of railroad, public utility, industrial and manufacturing enterprises.

Examination of proposed capital and consequential expenditures for facilities or equipment to ascertain whether they are justified and will improve conditions, increase revenues or reduce costs of operation and maintenance.

Assistance in connection with plans for financing projected improvements and extensions.

Review or preparation of plans, specifications and estimates of costs of contemplated new construction work, or enlargements of existing facilities.

Rehabilitation and modernization of unprofitable undertakings, including, if desired, their temporary management and operation until satisfactory results are obtained.

Advisory or consulting engineers to insure that expenditures are made in a manner that will produce maximum economic results and reflect the greatest return to the properties, and provide the best security to the owners.

Advisors and conferees in labor problems and in the preparation of rules and regulations governing compensation and working conditions.

Preparing, passing upon or approving inventories, valuations and appraisals of properties and equipment.

Consulting engineers for exporters and importers and their foreign representatives, to co-ordinate specifications, prices and purchases for the best interest of each.

Reporting on inventions, new methods and processes, and

assistance in the development of those having practical merit and commercial value.

J. E. Muhlfeld, who has been in transportation work for about 25 years, has, during the past ten years, been engaged in rehabilitation of roadway, terminals, shops and equipment on various railways, and more particularly in the design and development of the Mallet and other types of large steam locomotives in combination with the utilization of low-grade fuels for the purpose of increasing the average train load and reducing the costs of operation and maintenance on railroads in the United States, Canada and Brazil. He was born at Peru, Ind., on September 18, 1872, and studied mechanical engineering at Purdue University; he served as machinist, and then as locomotive fireman and engineer on the Wabash Railroad and later successively as engine house foreman and general foreman on the same road; master mechanic at Port Huron and Montreal, on the Grand Trunk; superintendent of machinery and rolling stock on the Canadian Government Railways; superintendent of motive power on the Baltimore & Ohio, and vice-president and general manager of the Kansas City Southern. During the past five years he has been located in New York and has specialized in railway and other valuation and improvement work and in the development of methods and appliances for the modernization of locomotives and central power stations for the purpose of reducing investment and fuel costs, utilizing waste heat, eliminating arduous labor, and increasing capacity.

V. Z. Caracristi has been engaged in railway and industrial work for the past 20 years, having specialized in locomotive, car and shop design and construction. He served as shop engineer and maintenance supervisor for the Richmond plant of the American Locomotive Company, and in the inauguration and installation of a uniform system of maintenance and shop betterment he was general maintenance supervisor for all of the plants of the same company. He assisted in the design and construction of the Washington, D. C., terminal and station, and later served as assistant to general superintendent of motive power of the Baltimore & Ohio, in charge of shop additions, construction and equipment, and general betterment of the design and construction of locomotives and cars, which included the design and construction of the first Mallet type locomotive. He was then engaged in carrying out improvements in the Brewster shops of the Wheeling & Lake Erie, and the Watervliet shops, and Carbondale mechanical terminal of the Delaware & Hudson Company; in charge of the layout, design and equipment of extensions to the Lima Locomotive Works, and various additions to plants and power houses of the American Locomotive Company. For the past six years he has been engaged in consulting work for various bankers on financial reports and suggesting improvements in industrial operating methods for controlled corporations. During this time he was engaged in development and commercial work on means and methods of burning coal in suspension. He will continue this same work in his new connection.

V. Z. Caracristi

CATALOGUES

ASH DISPOSAL.—The American Steam Conveyor Corporation, Chicago, has issued another booklet on the question of ash handling facilities, entitled "Reducing Ash Disposal Costs." Of special interest is a diagram and description of a steam ash conveyor installed by this company, that saved over three dollars a day in ash handling costs. The experiences of a number of other users in securing ash disposal economies are described, and the text is illustrated with a number of diagrams and photographs of actual installations.

CHAIN DRIVES.—The Morse Chain Company, Ithaca, N. Y., in a 12-page pamphlet has reprinted from the 1919 Year Book of the National Association of Cotton Manufacturers an article by J. S. White, entitled "Chain Drives," which explains the advantages which may be secured in the textile industry from the use of chain drives in general power transmission work. This is a short synopsis of the general subject of chain driving and does not exploit any particular make or type of power chain, and includes engineering data useful in designing silent chain drives.

ELECTRIC HEADLIGHTS.—The second edition of an instruction book covering the installation, care and operation of Sunbeam turbo-generators and headlights has been published by the Schroeder Headlight & Generator Company, Evansville, Ind. The information given in this book is quite extensive and not only deals with the Sunbeam turbo-generators and headlights, but contains considerable information pertaining to incandescent headlights in general, as well as many useful tables and formulae. It also contains many drawings and photographs showing detail parts and wiring arrangements.

LOCOMOTIVE COALING PLANTS.—A comprehensive book on locomotive coaling facilities, Rand gravity sand plants and cinder handling equipment for railroads, describing a large number of representative installations, has been published by the Roberts & Schaefer Company, Chicago. The catalogue contains 68 pages, 9 in. by 11½ in., is well illustrated and includes erection drawings of several of the plants. It also describes and illustrates some of the special features of Roberts & Schaefer equipment, including the Schraeder automatic measuring feeder and a patented elevating bucket. Some interesting data is also given showing in detail the cost of handling coal, taken from carefully compiled records of a large railway system which employs 10 different methods of handling coal, comparing the cost of operating plants designed by the Roberts & Schaefer Company with the others.

STOKER FIRED LOCOMOTIVES.—The Locomotive Stoker Company, Pittsburgh, Pa., has published an attractive booklet of 96 pages, bound in heavy cardboard covers, illustrating some of the principal types of locomotives that have been equipped with mechanical stokers by the Locomotive Stoker Company, which include the largest and most powerful locomotives constructed, as well as the standard locomotives of the United States Railroad Administration. The various types of locomotives considered to be in the stoker class are grouped in sections, each page containing an illustration of a representative locomotive of different railroads, with a table of the principal dimensions. After each section is a tabulation which permits of a direct comparison of the like dimensions of all locomotives of that class. These tables should be of special interest to mechanical engineers designing new locomotives, as well as to those contemplating installing stokers on old locomotives.